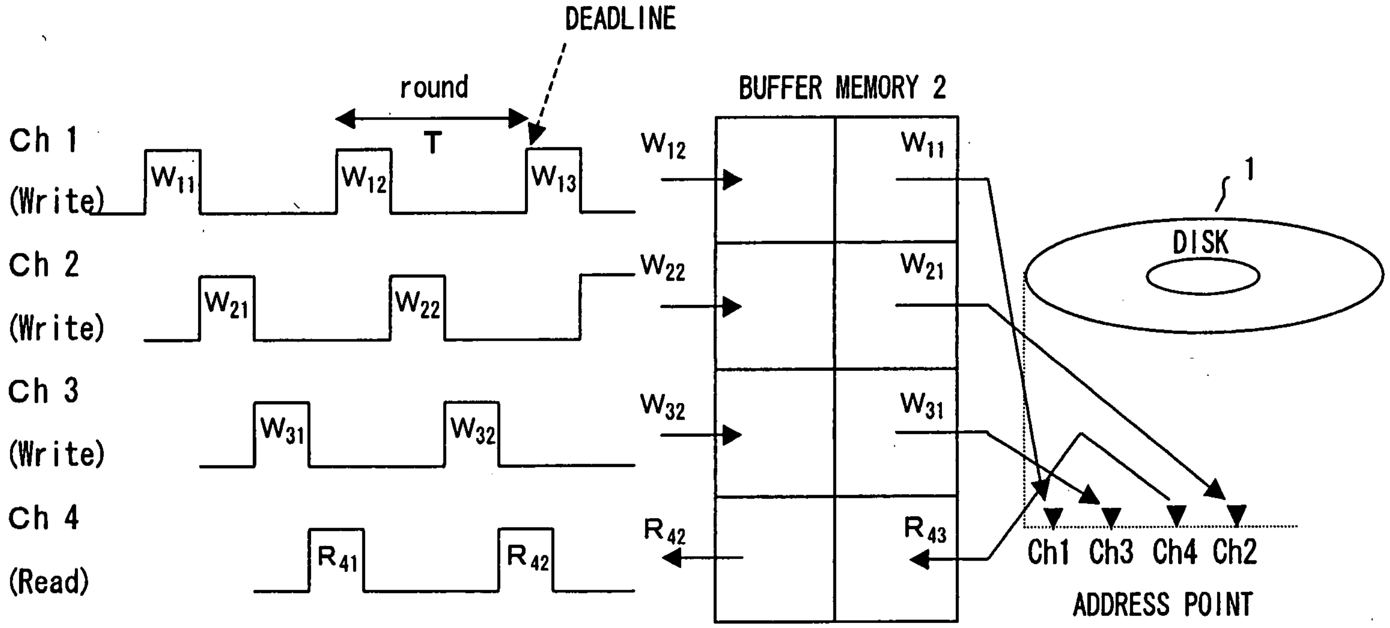
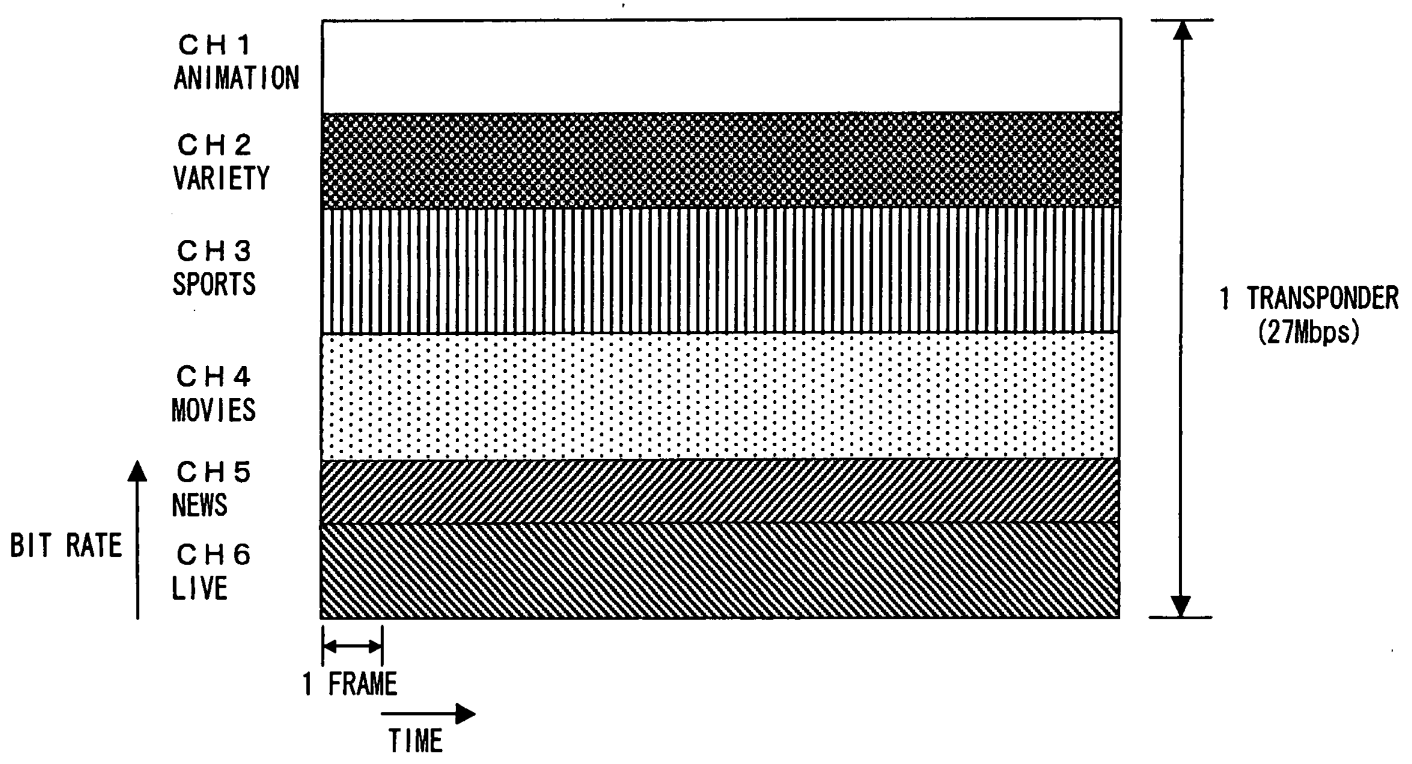


F I G. 1

PRIOR ART


CH1
ANIMATION
CH2
VARIETY
CH3
SPORTS
CH4
MOVIES
CH5
NEWS
CH6
LIVE
BIT RATE
1 FRAME
TIME
1 TRANSPONDER
(27Mbps)

F I G. 2

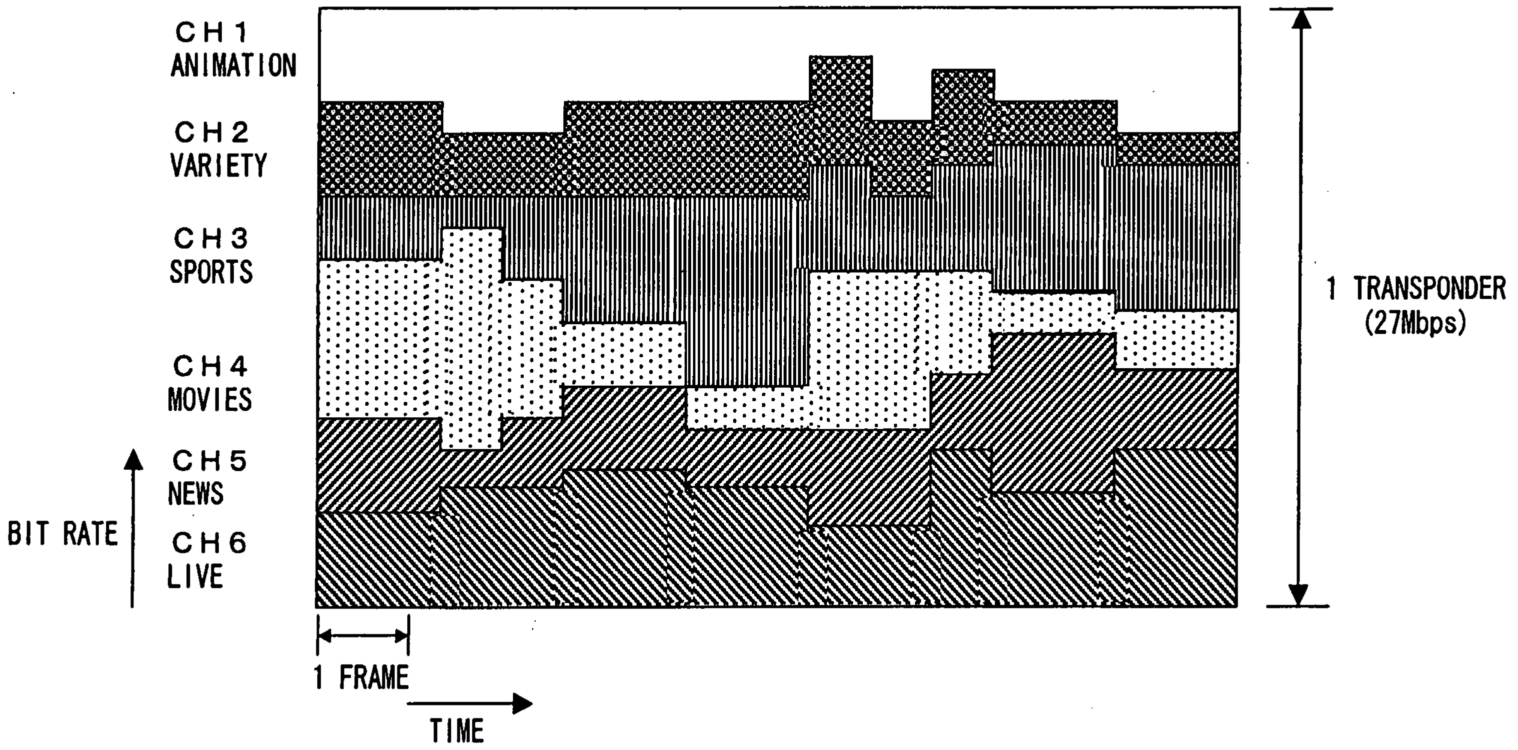

CH1
ANIMATION
CH2
VARIETY
CH3
SPORTS
CH4
MOVIES
CH5
NEWS
CH6
LIVE
BIT RATE
1 FRAME
TIME
1 TRANSPONDER
(27Mbps)

FIG. 3

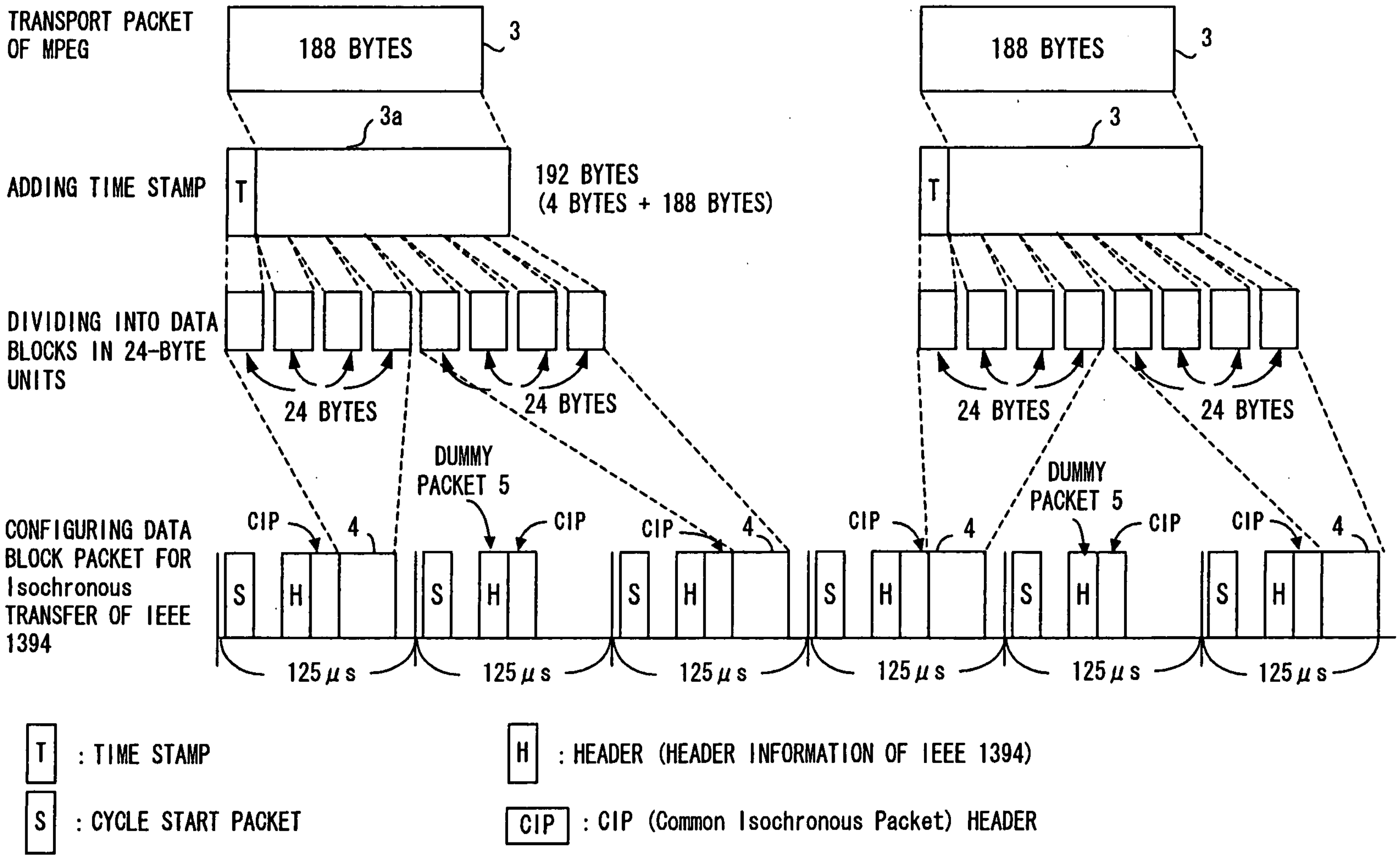

TRANSPORT PACKET OF MPEG
188 BYTES
3
188 BYTES
3
ADDING TIME STAMP
3a
T
192 BYTES (4 BYTES + 188 BYTES)
3
T
DIVIDING INTO DATA BLOCKS IN 24-BYTE UNITS
24 BYTES
24 BYTES
24 BYTES
24 BYTES
DUMMY PACKET 5
DUMMY PACKET 5
CONFIGURING DATA BLOCK PACKET FOR Isochronous TRANSFER OF IEEE 1394
CIP
4
CIP
CIP
4
CIP
4
CIP
CIP
4
S
H
125 μs
T : TIME STAMP
S : CYCLE START PACKET
H : HEADER (HEADER INFORMATION OF IEEE 1394)
CIP : CIP (Common Isochronous Packet) HEADER

FIG. 4

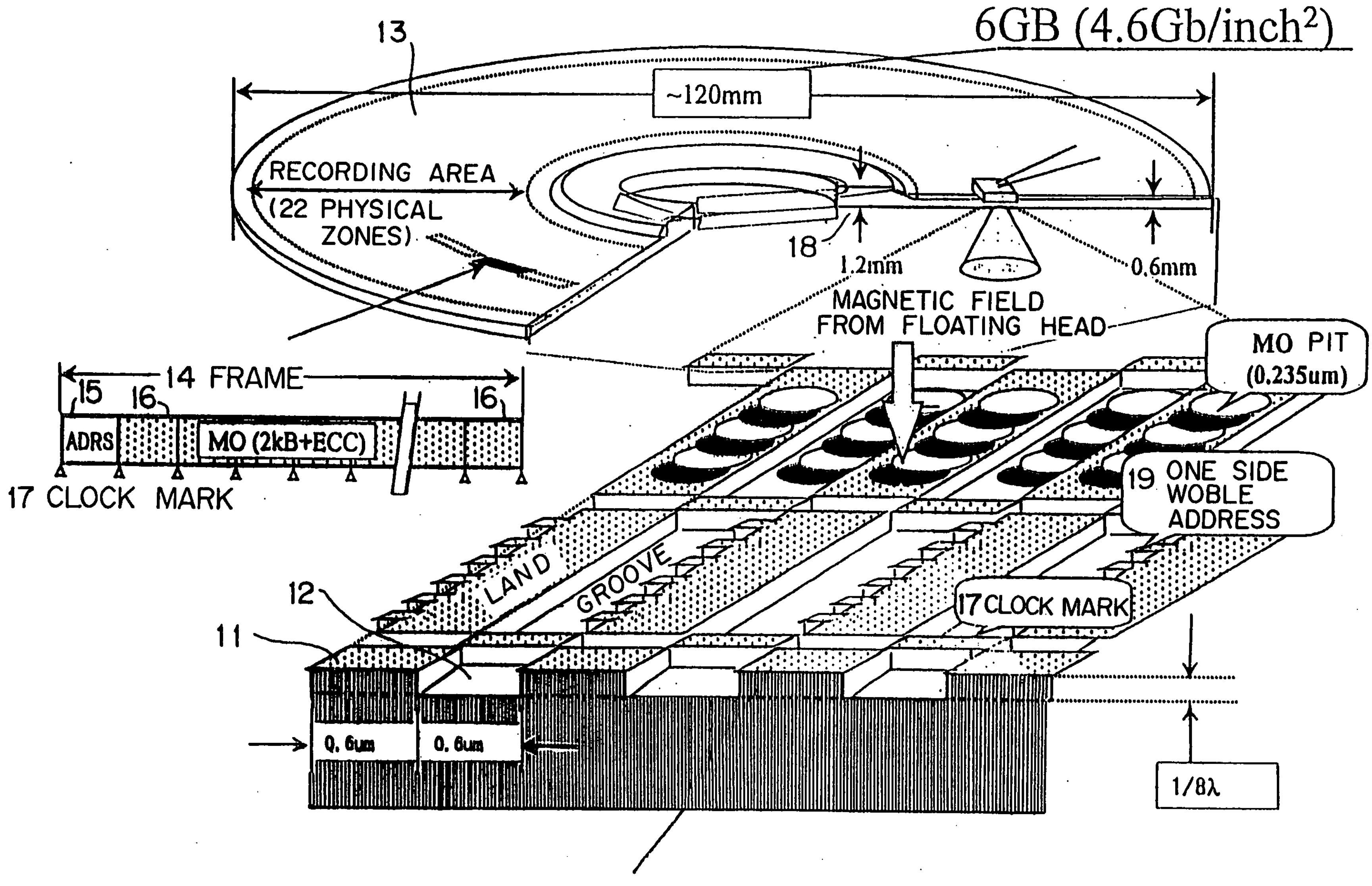

6GB (4.6Gb/inch^2)
13
~120mm
RECORDING AREA
(22 PHYSICAL ZONES)
18
1.2mm
0.6mm
MAGNETIC FIELD FROM FLOATING HEAD
MO PIT (0.235um)
14 FRAME
15
16
16
ADRS
MO (2kB+ECC)
17 CLOCK MARK
19 ONE SIDE WOBLE ADDRESS
LAND
GROOVE
12
11
17 CLOCK MARK
0.6um
0.6um
1/8λ

FIG. 5

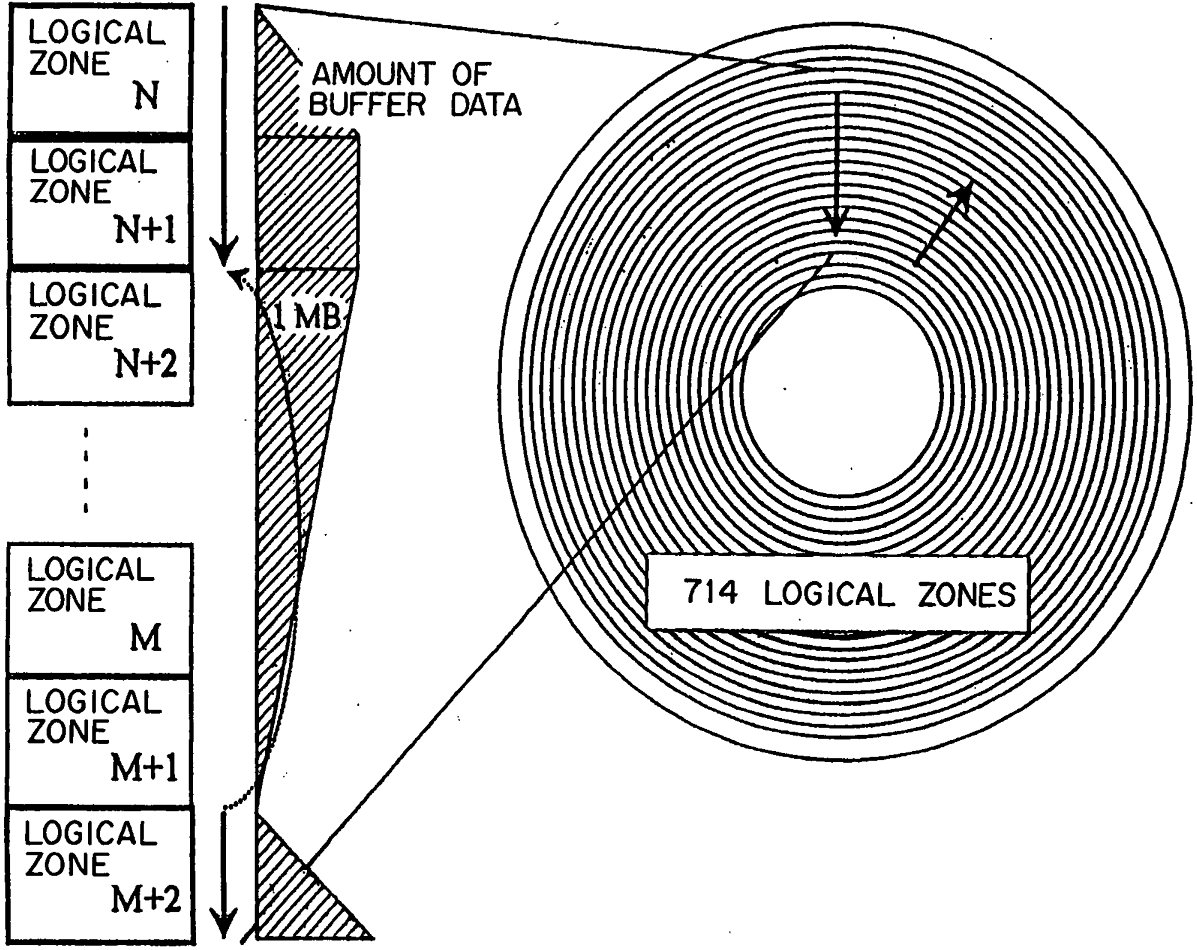

LOGICAL ZONE N
LOGICAL ZONE N+1
LOGICAL ZONE N+2
LOGICAL ZONE M
LOGICAL ZONE M+1
LOGICAL ZONE M+2
AMOUNT OF BUFFER DATA
1 MB
714 LOGICAL ZONES

FIG. 6

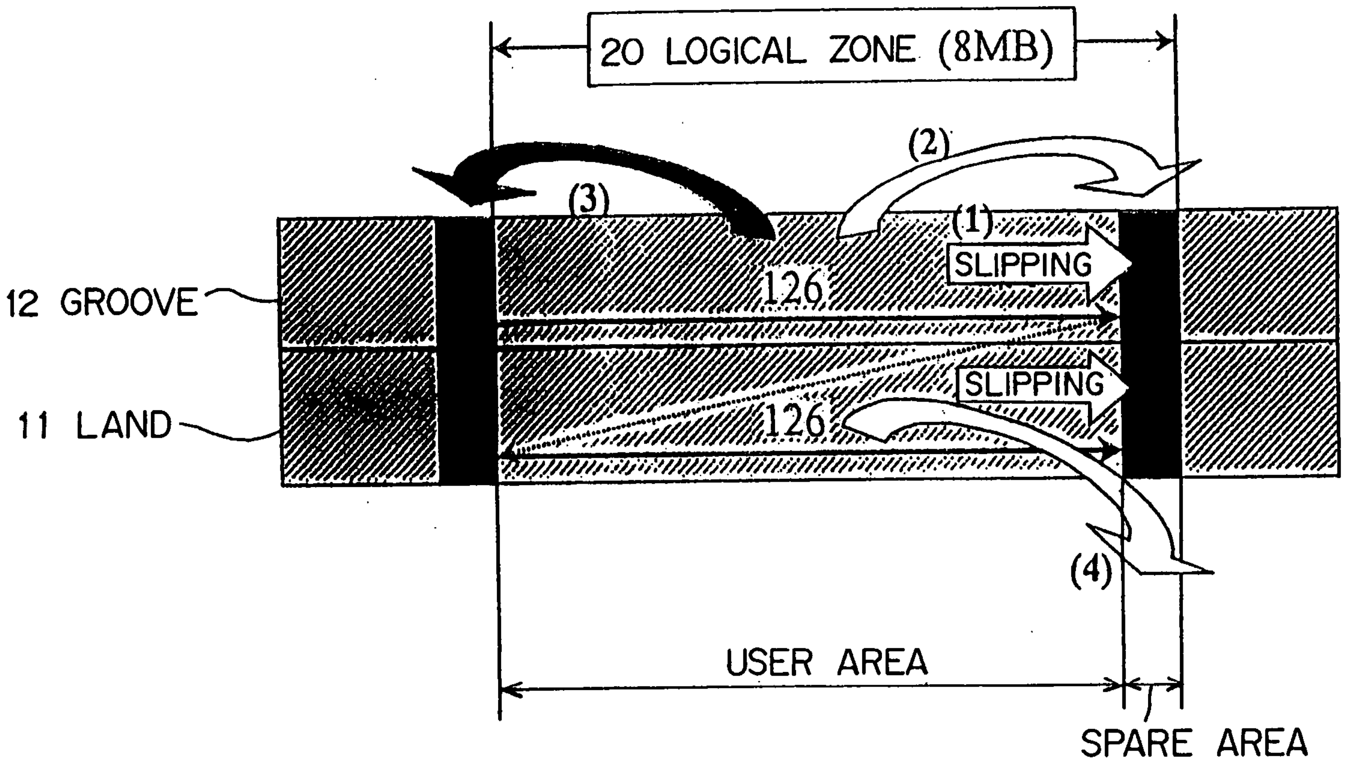

20 LOGICAL ZONE (8MB)
(1)
(2)
(3)
(4)
SLIPPING
SLIPPING
126
126
12 GROOVE
11 LAND
USER AREA
SPARE AREA

FIG. 7

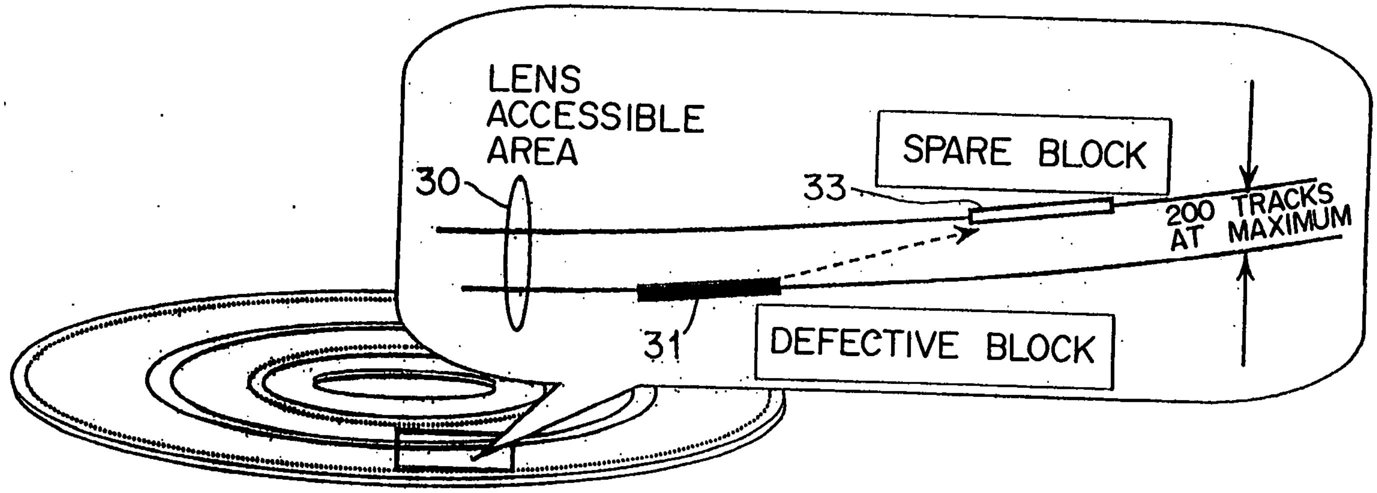

LENS
ACCESSIBLE
AREA
30
33
SPARE BLOCK
200 TRACKS
AT MAXIMUM
31
DEFECTIVE BLOCK

FIG. 8

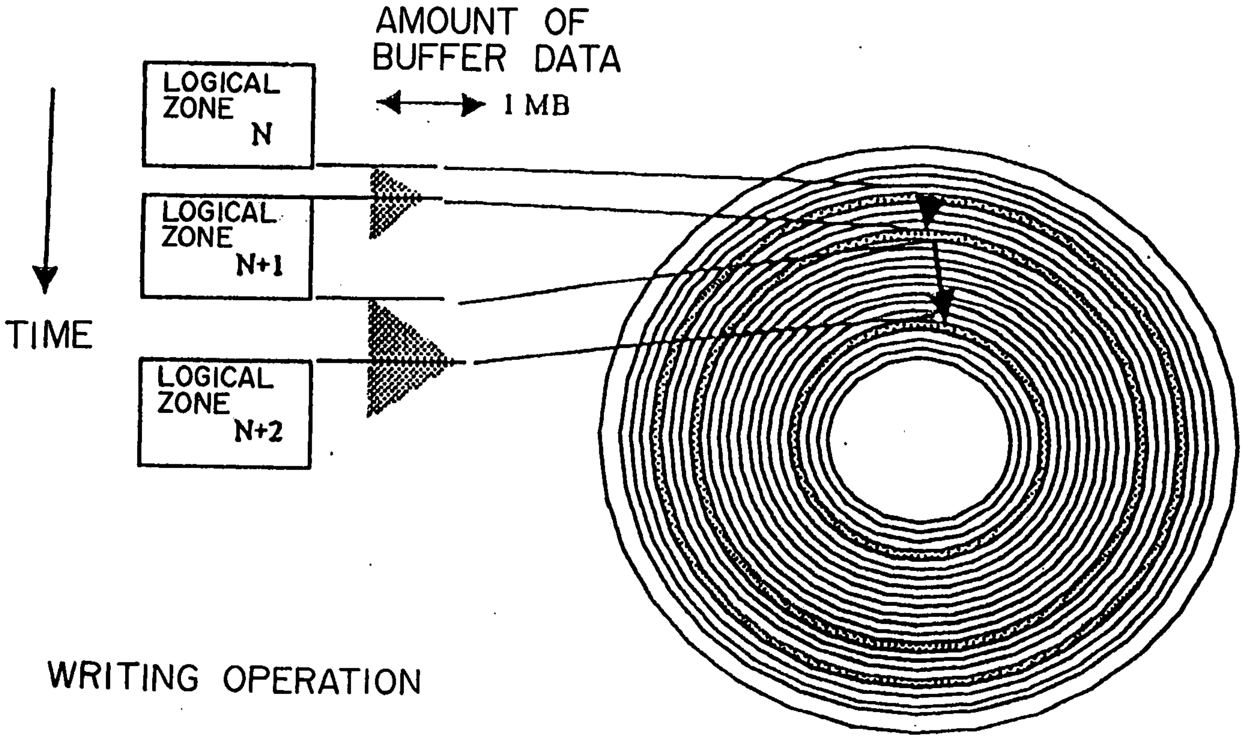

AMOUNT OF
BUFFER DATA
1 MB
LOGICAL ZONE N
LOGICAL ZONE N+1
LOGICAL ZONE N+2
TIME
WRITING OPERATION

FIG. 9

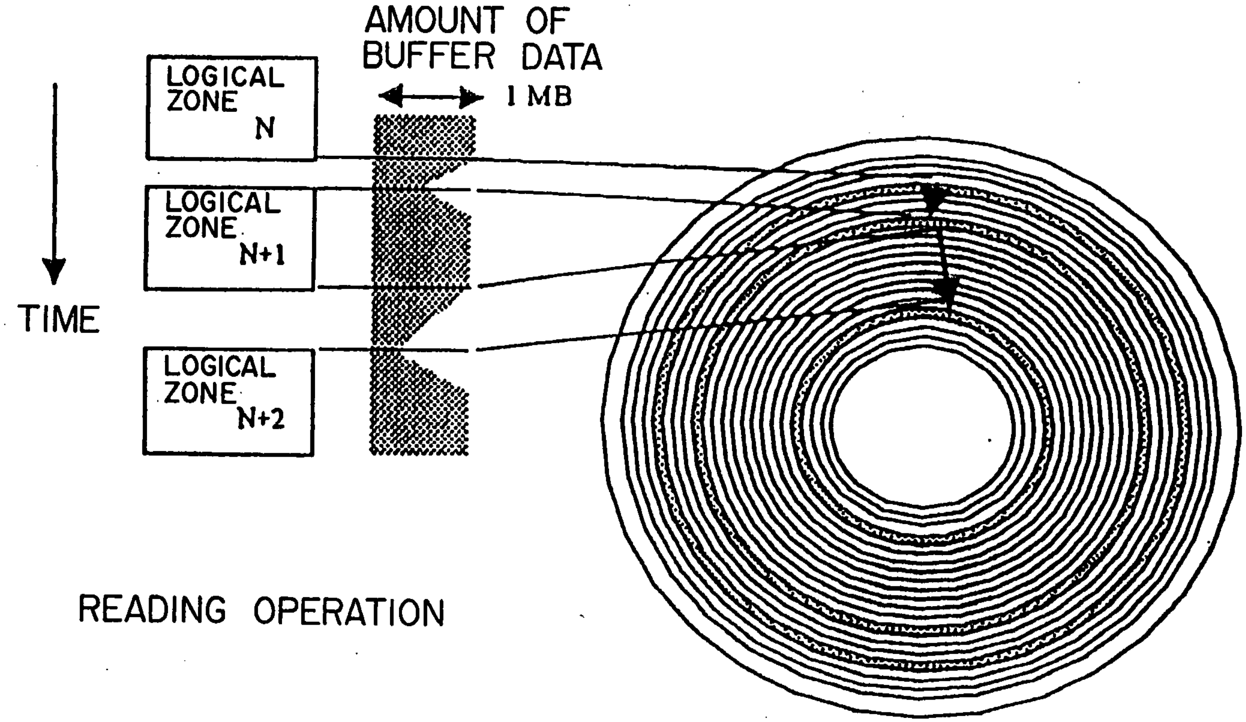

AMOUNT OF BUFFER DATA
1 MB
LOGICAL ZONE N
LOGICAL ZONE N+1
LOGICAL ZONE N+2
TIME
READING OPERATION

FIG. 10

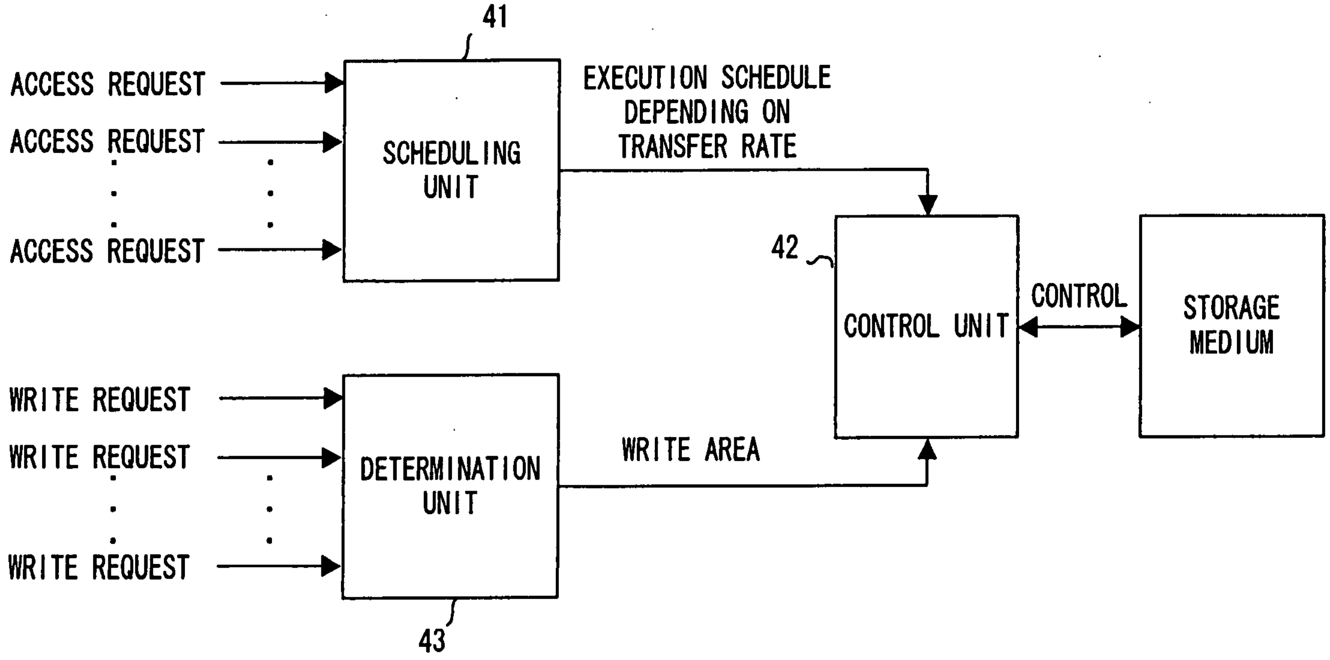
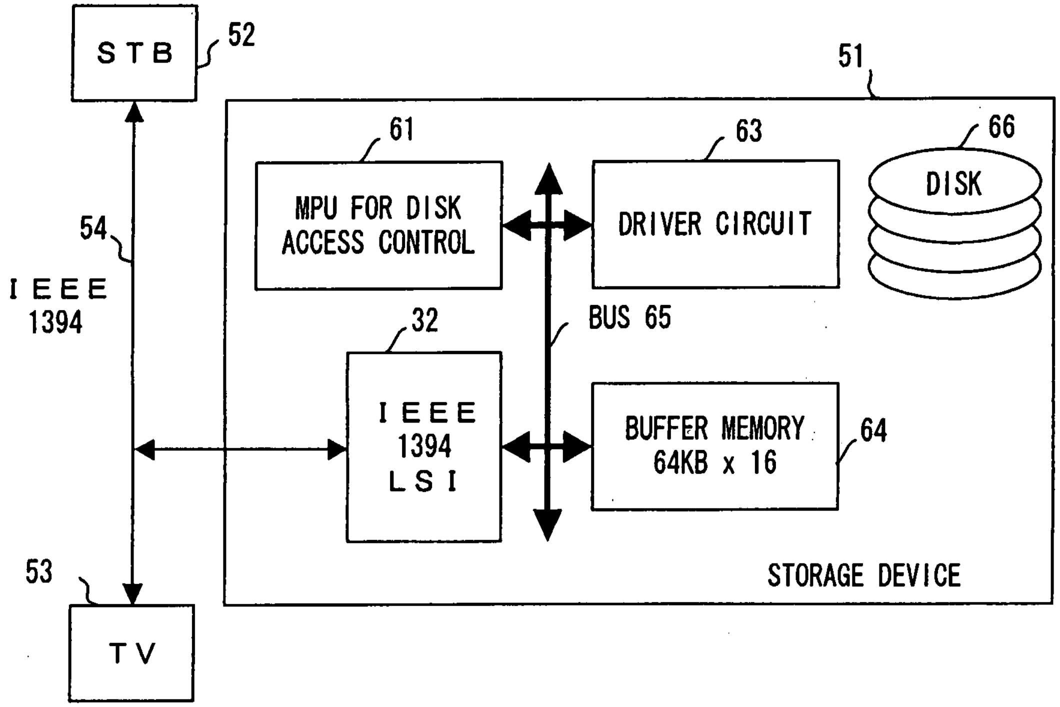

41
ACCESS REQUEST
ACCESS REQUEST
ACCESS REQUEST
SCHEDULING UNIT
EXECUTION SCHEDULE DEPENDING ON TRANSFER RATE
42
CONTROL UNIT
CONTROL
STORAGE MEDIUM
WRITE REQUEST
WRITE REQUEST
WRITE REQUEST
DETERMINATION UNIT
WRITE AREA
43

FIG. 11


S T B
52
51
61
63
66
MPU FOR DISK
ACCESS CONTROL
DRIVER CIRCUIT
DISK
54
I E E E
1394
32
BUS 65
I E E E
1394
L S I
BUFFER MEMORY
64KB x 16
64
53
STORAGE DEVICE
T V

F I G. 1 2

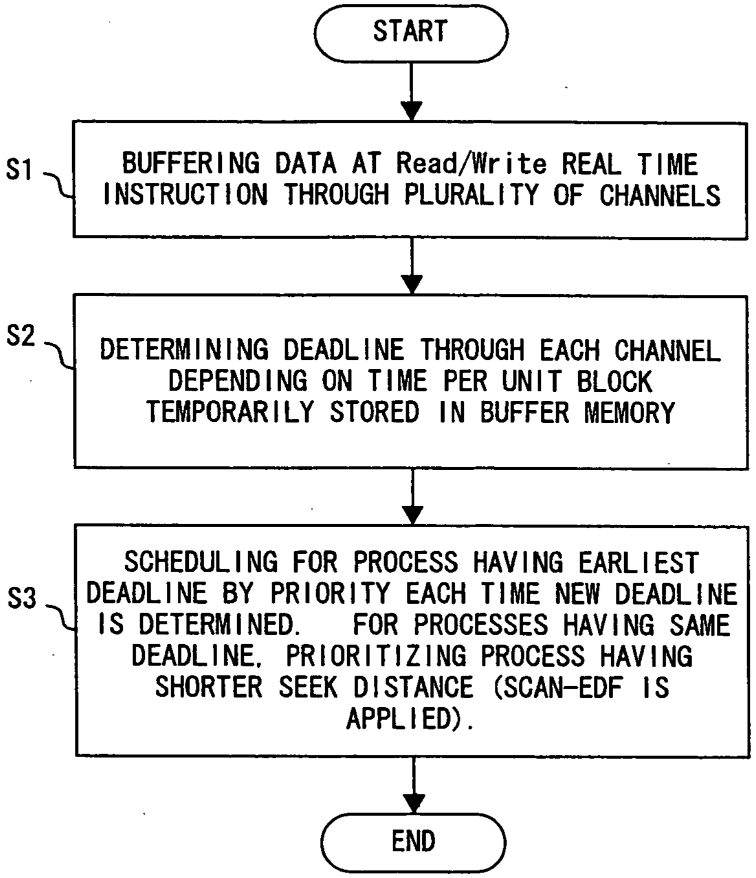

START
S1
BUFFERING DATA AT Read/Write REAL TIME INSTRUCTION THROUGH PLURALITY OF CHANNELS
S2
DETERMINING DEADLINE THROUGH EACH CHANNEL DEPENDING ON TIME PER UNIT BLOCK TEMPORARILY STORED IN BUFFER MEMORY
S3
SCHEDULING FOR PROCESS HAVING EARLIEST DEADLINE BY PRIORITY EACH TIME NEW DEADLINE IS DETERMINED. FOR PROCESSES HAVING SAME DEADLINE, PRIORITIZING PROCESS HAVING SHORTER SEEK DISTANCE (SCAN-EDF IS APPLIED).
END

FIG. 13

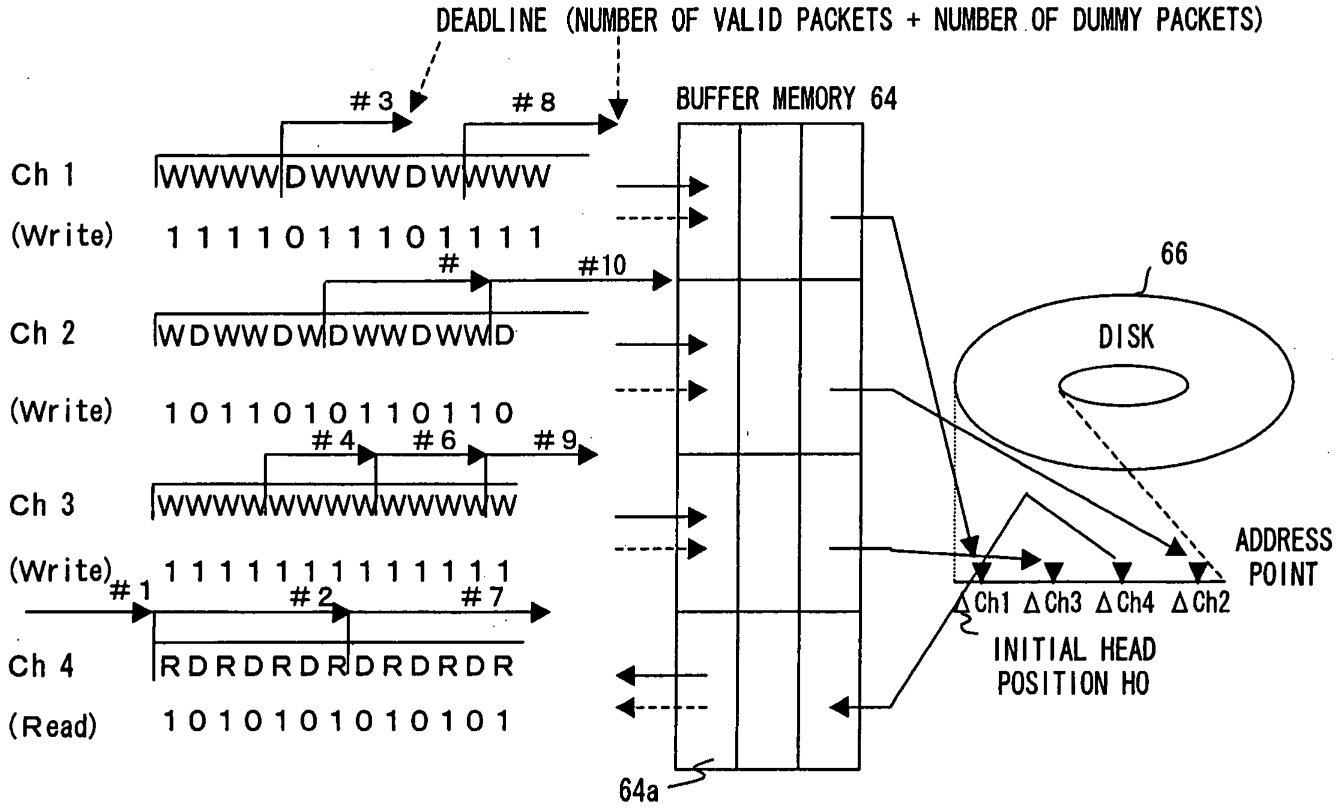
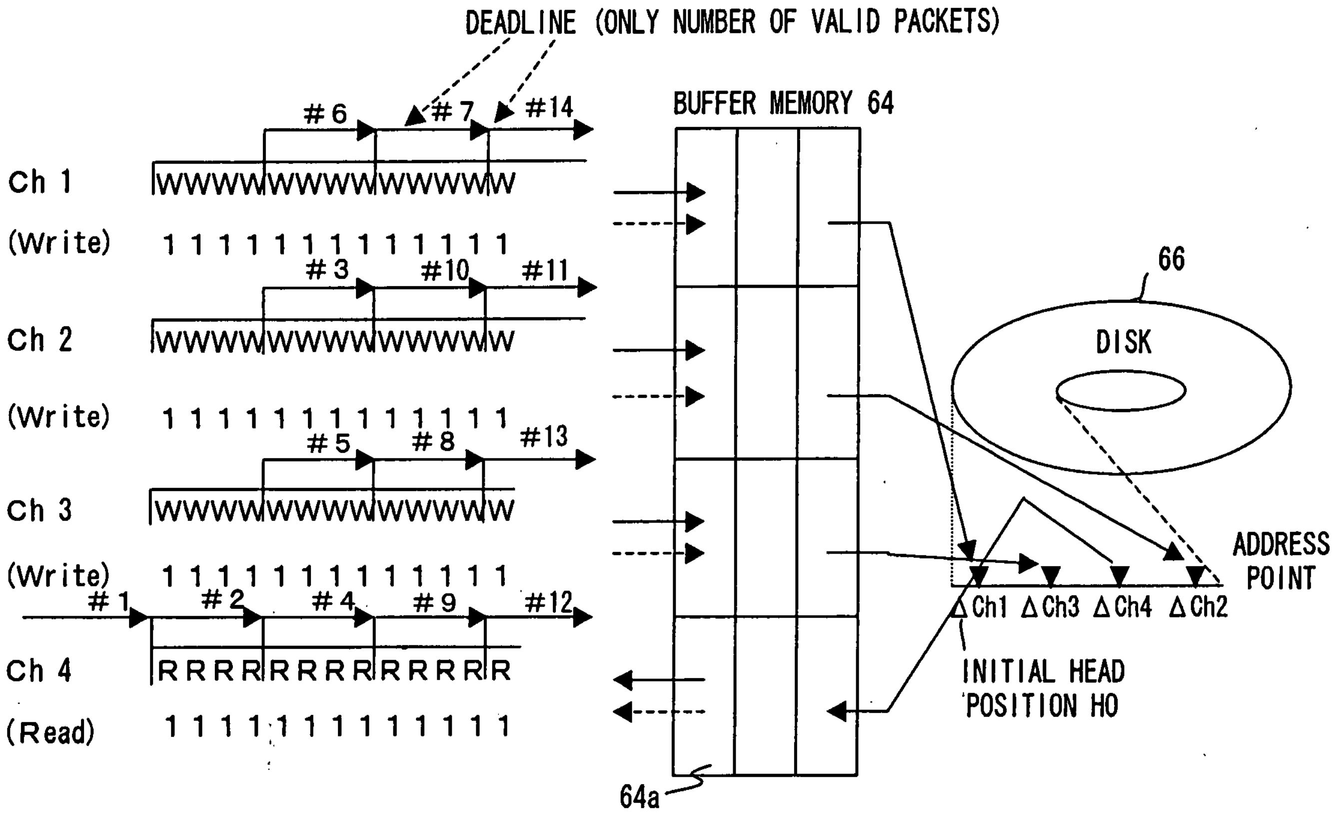

DEADLINE (NUMBER OF VALID PACKETS + NUMBER OF DUMMY PACKETS)
#3
#8
BUFFER MEMORY 64
Ch 1
WWWWDWWWDWWWW
(Write)
1111011101111
#
#10
Ch 2
WDWWDWDWWDWWD
(Write)
1011010110110
#4
#6
#9
Ch 3
WWWWWWWWWWWWW
(Write)
1111111111111
#1
#2
#7
Ch 4
RDRDRDRDRDRDR
(Read)
1010101010101
64a
66
DISK
ADDRESS POINT
ΔCh1 ΔCh3 ΔCh4 ΔCh2
INITIAL HEAD POSITION H0

FIG. 14

MAXIMUM TRANSFER RATE (NUMBER OF BYTES/ NUMBER OF PACKETS)	DEADLINE INFORMATION	BINARY DATA	VALID DATA

FIG. 15


DEADLINE (ONLY NUMBER OF VALID PACKETS)
BUFFER MEMORY 64
#6
#7
#14
Ch 1
WWWWWWWWWWWWWWW
(Write)
1 1 1 1 1 1 1 1 1 1 1 1 1
#3
#10
#11
Ch 2
WWWWWWWWWWWWWWW
(Write)
1 1 1 1 1 1 1 1 1 1 1 1 1
#5
#8
#13
Ch 3
WWWWWWWWWWWWWWW
(Write)
1 1 1 1 1 1 1 1 1 1 1 1 1
#1
#2
#4
#9
#12
Ch 4
RRRRRRRRRRRRR
(Read)
1 1 1 1 1 1 1 1 1 1 1 1 1
66
DISK
ADDRESS POINT
ΔCh1 ΔCh3 ΔCh4 ΔCh2
INITIAL HEAD POSITION H0
64a

F I G. 1 6

70

PROCESS ORDER	DEADLINE T	R/W	CHANNEL C	BLOCK ADDRESS A ON DISK
1	Ti	Wi	Ci	Ai
⋮	⋮	⋮	⋮	⋮
m-1	Tj	Rj	Cj	Aj
REGISTRATION → m	Tk	Rk	Ck	Ak
⋮	⋮	⋮	⋮	⋮
2N				

Order(1)= {T, R/W, C, A}

FIG. 17

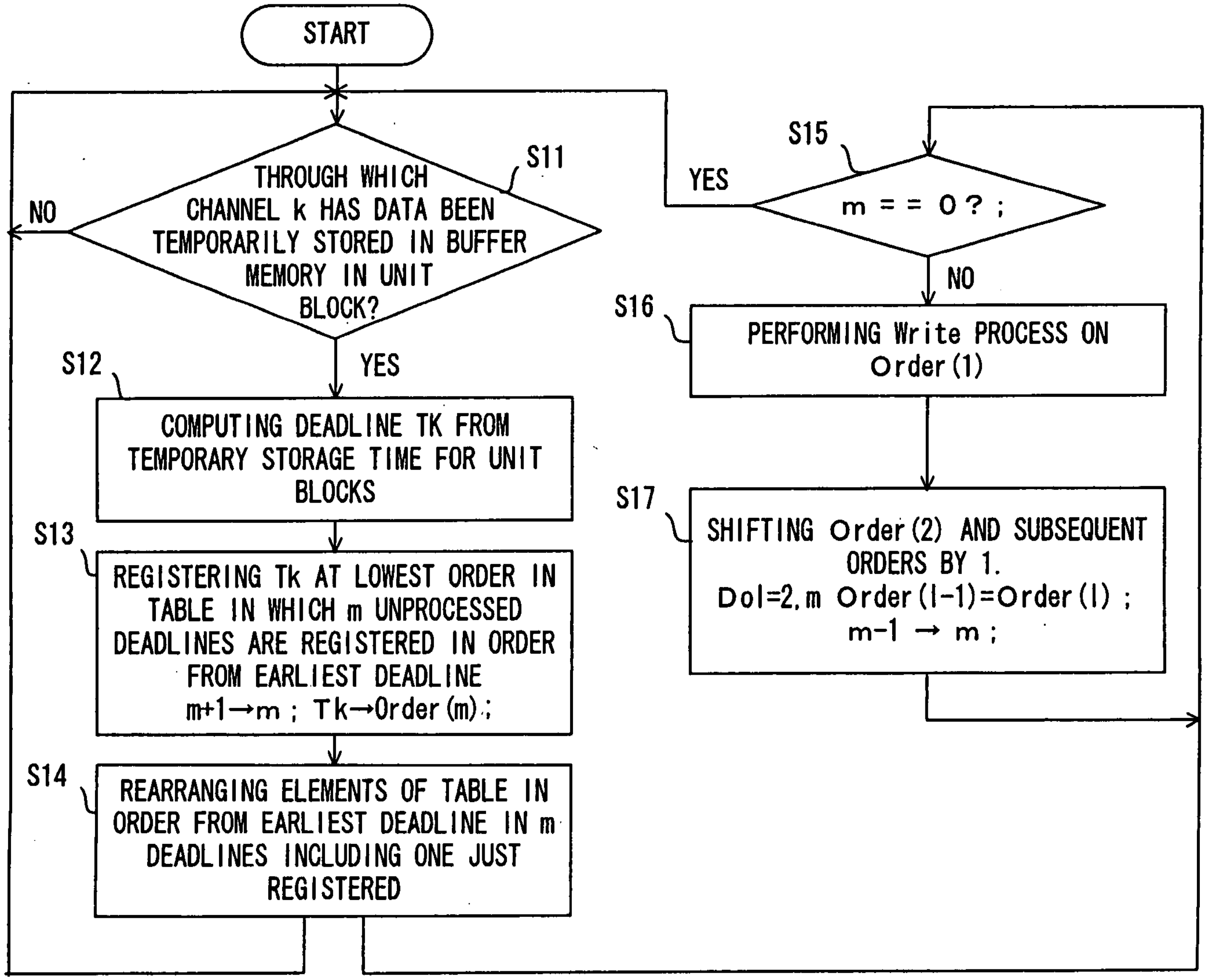
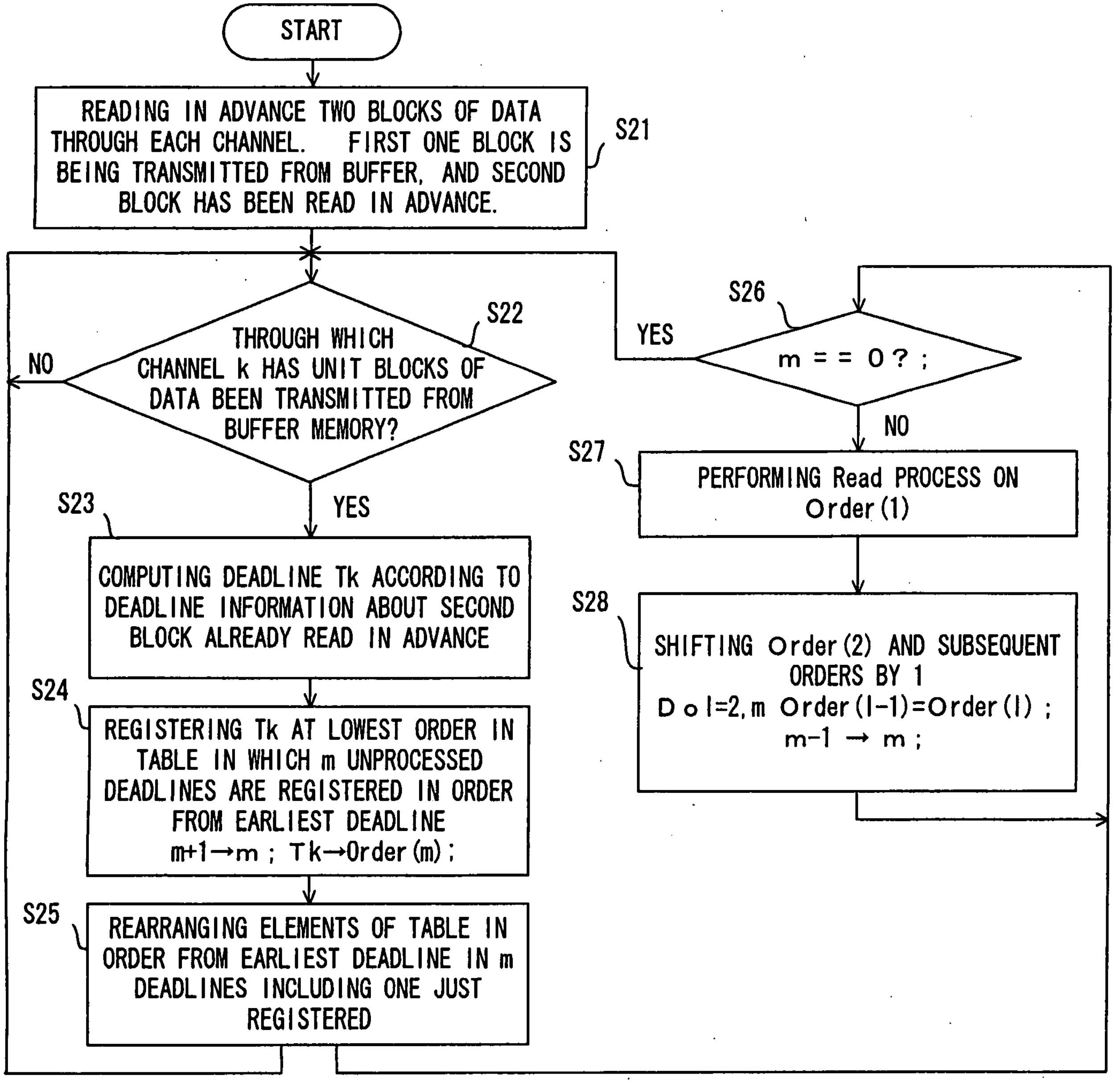

START
S11
THROUGH WHICH CHANNEL k HAS DATA BEEN TEMPORARILY STORED IN BUFFER MEMORY IN UNIT BLOCK?
NO
YES
S12
COMPUTING DEADLINE TK FROM TEMPORARY STORAGE TIME FOR UNIT BLOCKS
S13
REGISTERING Tk AT LOWEST ORDER IN TABLE IN WHICH m UNPROCESSED DEADLINES ARE REGISTERED IN ORDER FROM EARLIEST DEADLINE
m+1→m ; Tk→Order (m) ;
S14
REARRANGING ELEMENTS OF TABLE IN ORDER FROM EARLIEST DEADLINE IN m DEADLINES INCLUDING ONE JUST REGISTERED
S15
YES
m = = 0 ? ;
NO
S16
PERFORMING Write PROCESS ON Order (1)
S17
SHIFTING Order (2) AND SUBSEQUENT ORDERS BY 1.
Do l=2, m Order (l-1)=Order (l) ;
m-1 → m ;

FIG. 18


START
READING IN ADVANCE TWO BLOCKS OF DATA THROUGH EACH CHANNEL. FIRST ONE BLOCK IS BEING TRANSMITTED FROM BUFFER, AND SECOND BLOCK HAS BEEN READ IN ADVANCE.
S21
S22
THROUGH WHICH CHANNEL k HAS UNIT BLOCKS OF DATA BEEN TRANSMITTED FROM BUFFER MEMORY?
NO
YES
S23
COMPUTING DEADLINE Tk ACCORDING TO DEADLINE INFORMATION ABOUT SECOND BLOCK ALREADY READ IN ADVANCE
S24
REGISTERING Tk AT LOWEST ORDER IN TABLE IN WHICH m UNPROCESSED DEADLINES ARE REGISTERED IN ORDER FROM EARLIEST DEADLINE
m+1→m ; Tk→Order(m);
S25
REARRANGING ELEMENTS OF TABLE IN ORDER FROM EARLIEST DEADLINE IN m DEADLINES INCLUDING ONE JUST REGISTERED
S26
YES
m = = 0 ? ;
NO
S27
PERFORMING Read PROCESS ON Order(1)
S28
SHIFTING Order(2) AND SUBSEQUENT ORDERS BY 1
D o l=2, m Order(l-1)=Order(l) ;
m-1 → m ;

F I G. 1 9

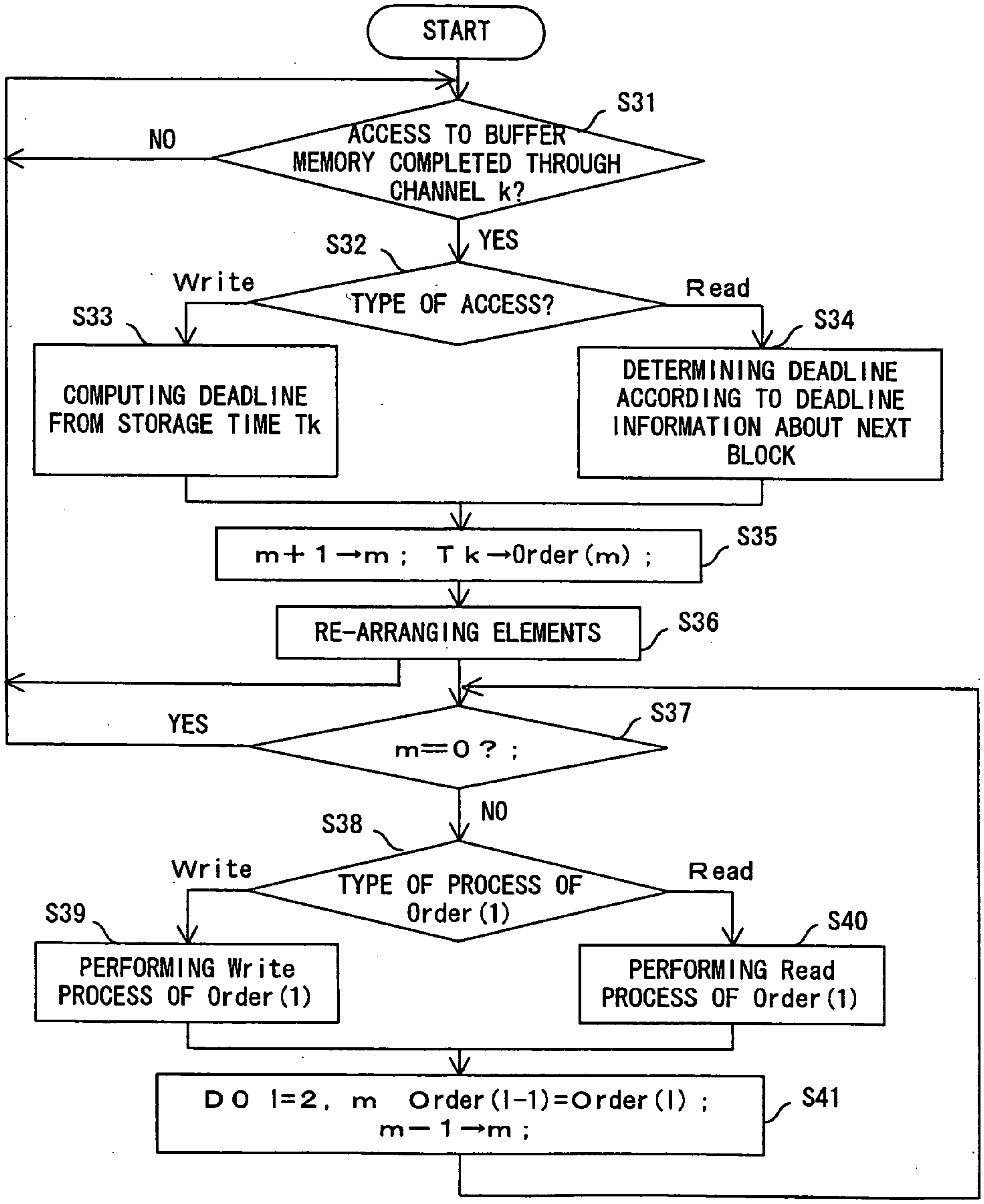

START
S31
ACCESS TO BUFFER MEMORY COMPLETED THROUGH CHANNEL k?
NO
YES
S32
TYPE OF ACCESS?
Write
Read
S33
COMPUTING DEADLINE FROM STORAGE TIME Tk
S34
DETERMINING DEADLINE ACCORDING TO DEADLINE INFORMATION ABOUT NEXT BLOCK
S35
m+1→m ; Tk→Order(m) ;
S36
RE-ARRANGING ELEMENTS
S37
YES
m=0 ? ;
NO
S38
TYPE OF PROCESS OF Order(1)
Write
Read
S39
PERFORMING Write PROCESS OF Order(1)
S40
PERFORMING Read PROCESS OF Order(1)
S41
DO l=2, m Order(l-1)=Order(l) ;
m-1→m ;

FIG. 20

```
→ Tk(m)>Tj(m-1)? → COMPLETED;
  Tk(m)==Tj(m-1)?
      {Ak(m)-Ah>Aj(m-1)-Ah? → COMPLETED}
  EXCHANGING Order(m) AND Order(m-1);
  m-1 → m;
```

FIG. 21

Tk(m)>Tj(m／2)? → >Tj(3m／4)?

CONTINUING

<Tj(3m／4)?

Tk(m)<Tj(m／2)? → >Tj(m／4)?

CONTINUING

<Tj(m／4)?

INSERTING Order(m) IN ORDER OF DETERMINATION;

FIG. 22

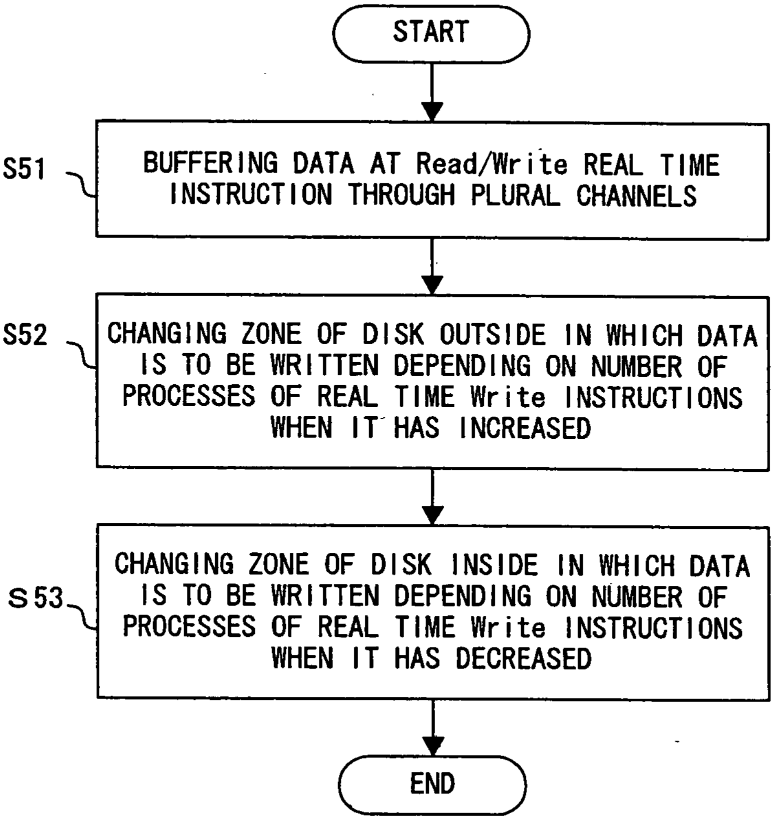

START
S51
BUFFERING DATA AT Read/Write REAL TIME INSTRUCTION THROUGH PLURAL CHANNELS
S52
CHANGING ZONE OF DISK OUTSIDE IN WHICH DATA IS TO BE WRITTEN DEPENDING ON NUMBER OF PROCESSES OF REAL TIME Write INSTRUCTIONS WHEN IT HAS INCREASED
S53
CHANGING ZONE OF DISK INSIDE IN WHICH DATA IS TO BE WRITTEN DEPENDING ON NUMBER OF PROCESSES OF REAL TIME Write INSTRUCTIONS WHEN IT HAS DECREASED
END

FIG. 23

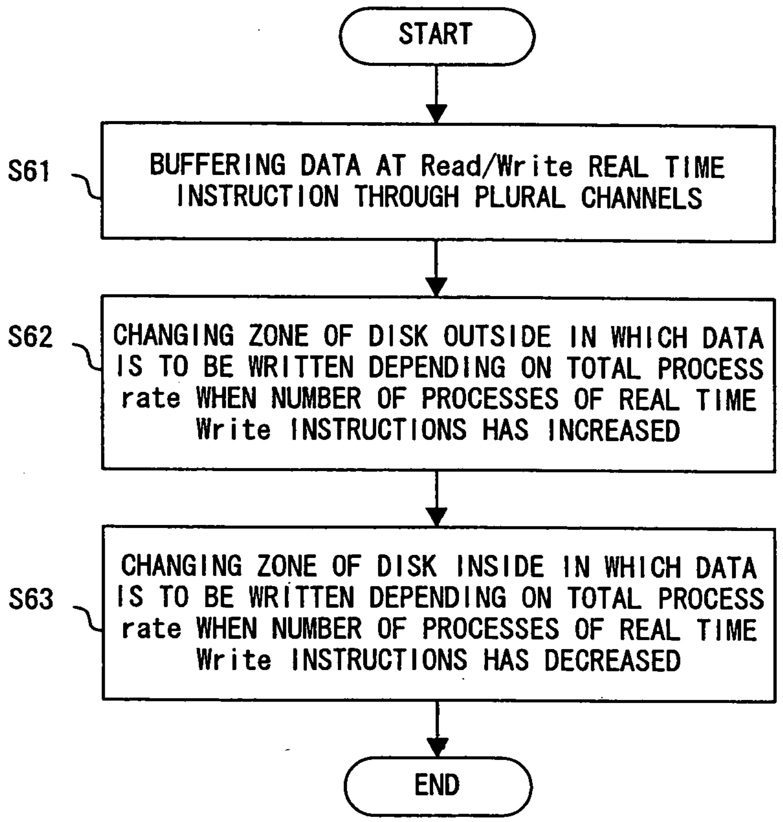
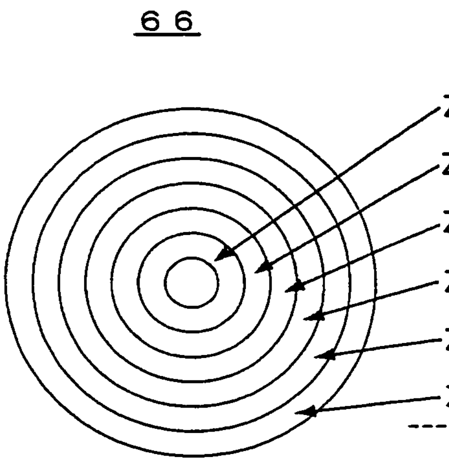

START
S61
BUFFERING DATA AT Read/Write REAL TIME INSTRUCTION THROUGH PLURAL CHANNELS
S62
CHANGING ZONE OF DISK OUTSIDE IN WHICH DATA IS TO BE WRITTEN DEPENDING ON TOTAL PROCESS rate WHEN NUMBER OF PROCESSES OF REAL TIME Write INSTRUCTIONS HAS INCREASED
S63
CHANGING ZONE OF DISK INSIDE IN WHICH DATA IS TO BE WRITTEN DEPENDING ON TOTAL PROCESS rate WHEN NUMBER OF PROCESSES OF REAL TIME Write INSTRUCTIONS HAS DECREASED
END

FIG. 24



	NUMBERS OF BYTES/TRACK,	TRANSFER RATE
ZONE Z1 :	92KB	15.4 MB/s
ZONE Z2 :	100KB	16.8 MB/s
ZONE Z3 :	108KB	18.1 MB/s
ZONE Z4 :	116KB	19.5 MB/s
ZONE Z5 :	124KB	20.9 MB/s
ZONE Z6 :	132KB	22.3 MB/s
AVERAGE :	112KB	18.8 MB/s

FIG. 25

NUMBER OF CHANNELS	TRACK DIRECTION (CIRCULAR) →						ZONE
1	Ch 1	Ch 1	Ch 1	Ch 1	Ch 1	Ch 1	Z 1
2	Ch 1	Ch 2	Ch 1	Ch 2	Ch 1	Ch 2	Z 2
3	Ch 1	Ch 2	Ch 3	Ch 1	Ch 2	Ch 3	Z 3
4	Ch 1	Ch 2	Ch 3	Ch 4	Ch 1	Ch 2	Z 4
5	Ch 1	Ch 2	Ch 3	Ch 4	Ch 5	Ch 1	Z 5
6	Ch 1	Ch 2	Ch 3	Ch 4	Ch 5	Ch 6	Z 6

FIG. 26

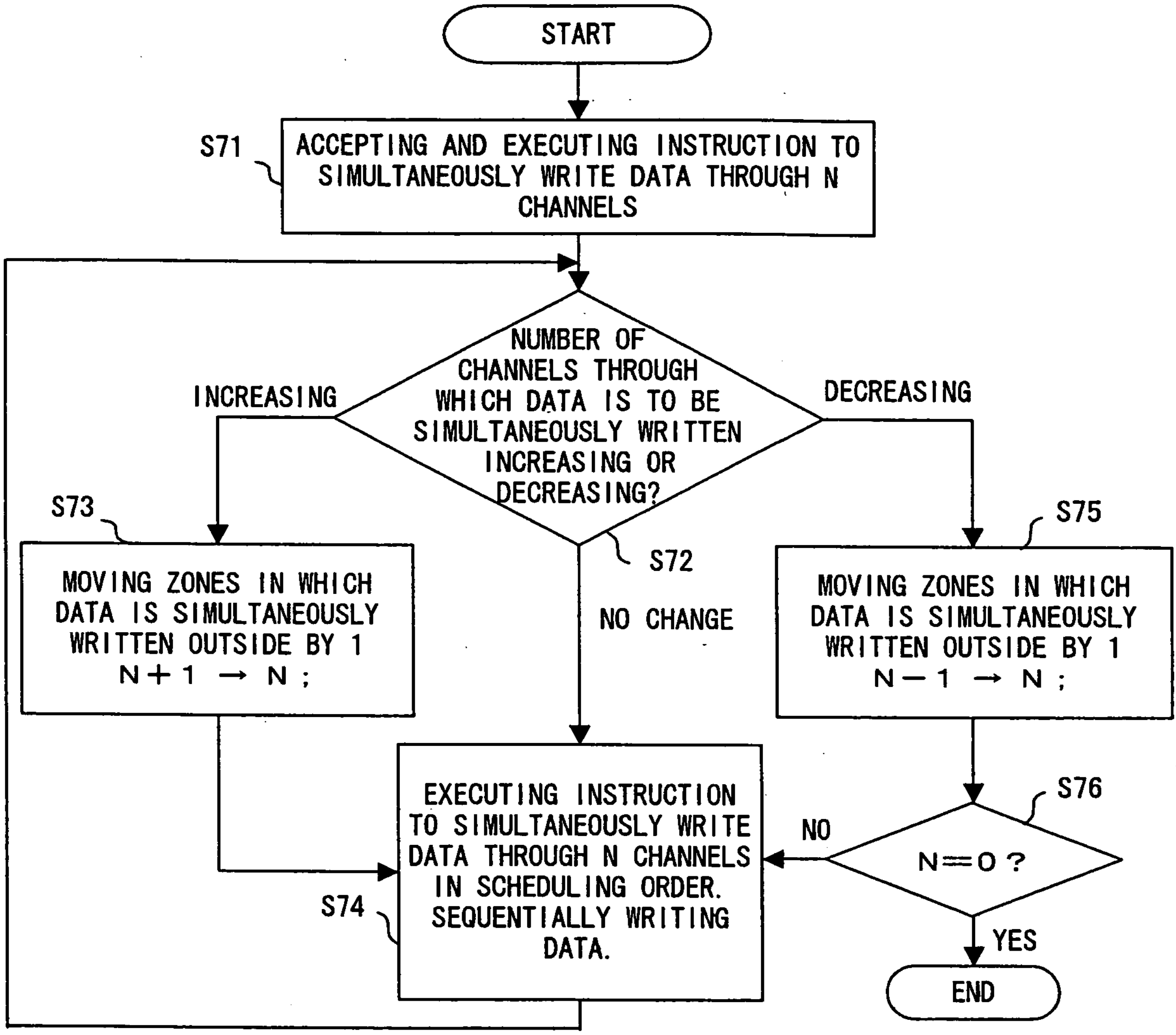

START
S71
ACCEPTING AND EXECUTING INSTRUCTION TO SIMULTANEOUSLY WRITE DATA THROUGH N CHANNELS
NUMBER OF CHANNELS THROUGH WHICH DATA IS TO BE SIMULTANEOUSLY WRITTEN INCREASING OR DECREASING?
INCREASING
DECREASING
S72
S73
MOVING ZONES IN WHICH DATA IS SIMULTANEOUSLY WRITTEN OUTSIDE BY 1 N+1 → N;
NO CHANGE
S75
MOVING ZONES IN WHICH DATA IS SIMULTANEOUSLY WRITTEN OUTSIDE BY 1 N−1 → N;
S74
EXECUTING INSTRUCTION TO SIMULTANEOUSLY WRITE DATA THROUGH N CHANNELS IN SCHEDULING ORDER. SEQUENTIALLY WRITING DATA.
S76
NO
N=0?
YES
END

FIG. 27

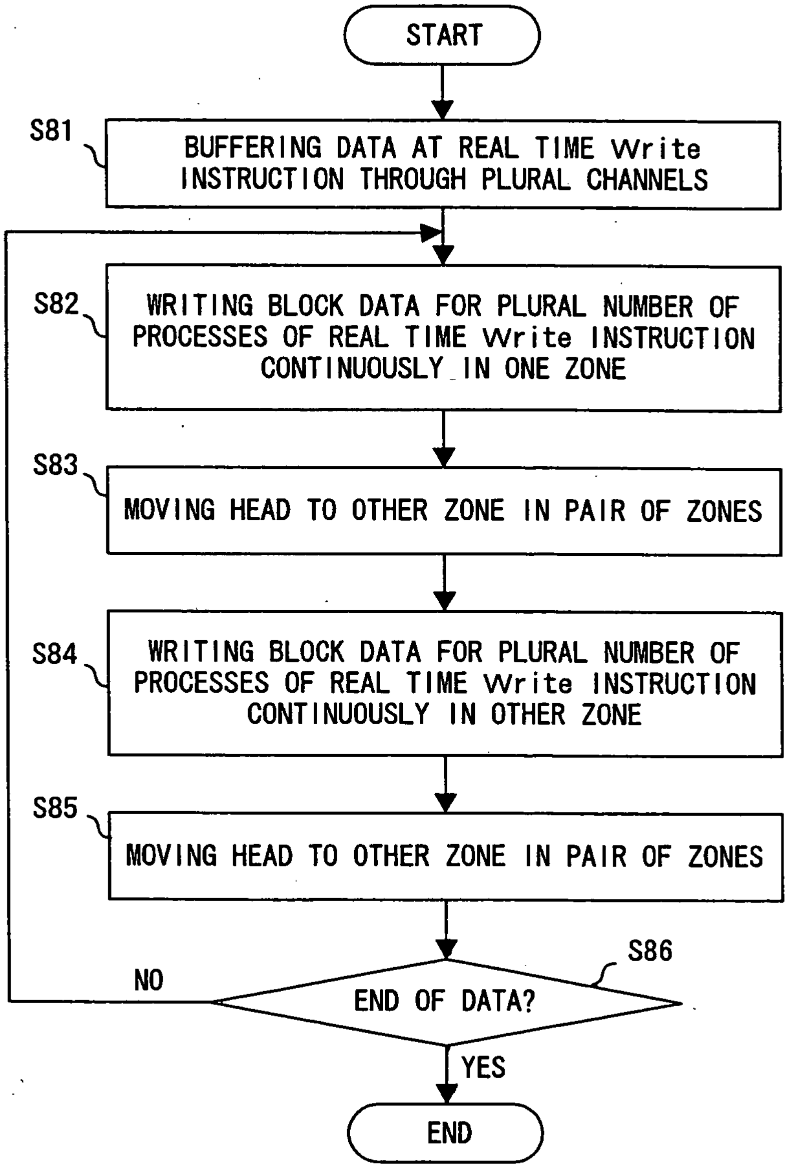

START
S81
BUFFERING DATA AT REAL TIME Write INSTRUCTION THROUGH PLURAL CHANNELS
S82
WRITING BLOCK DATA FOR PLURAL NUMBER OF PROCESSES OF REAL TIME Write INSTRUCTION CONTINUOUSLY IN ONE ZONE
S83
MOVING HEAD TO OTHER ZONE IN PAIR OF ZONES
S84
WRITING BLOCK DATA FOR PLURAL NUMBER OF PROCESSES OF REAL TIME Write INSTRUCTION CONTINUOUSLY IN OTHER ZONE
S85
MOVING HEAD TO OTHER ZONE IN PAIR OF ZONES
S86
END OF DATA?
NO
YES
END

FIG. 28

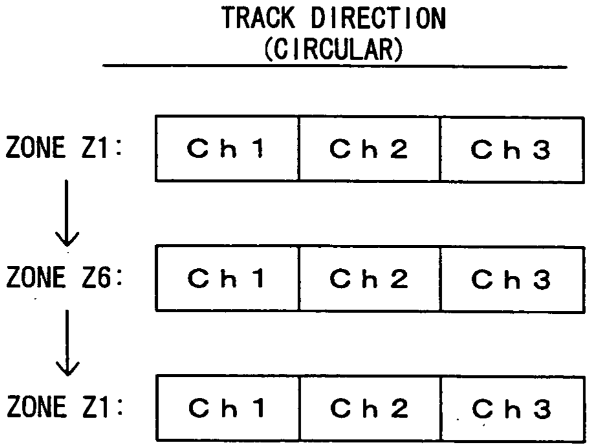

TRACK DIRECTION
(CIRCULAR)
ZONE Z1:
Ch 1
Ch 2
Ch 3
ZONE Z6:
Ch 1
Ch 2
Ch 3
ZONE Z1:
Ch 1
Ch 2
Ch 3

FIG. 29

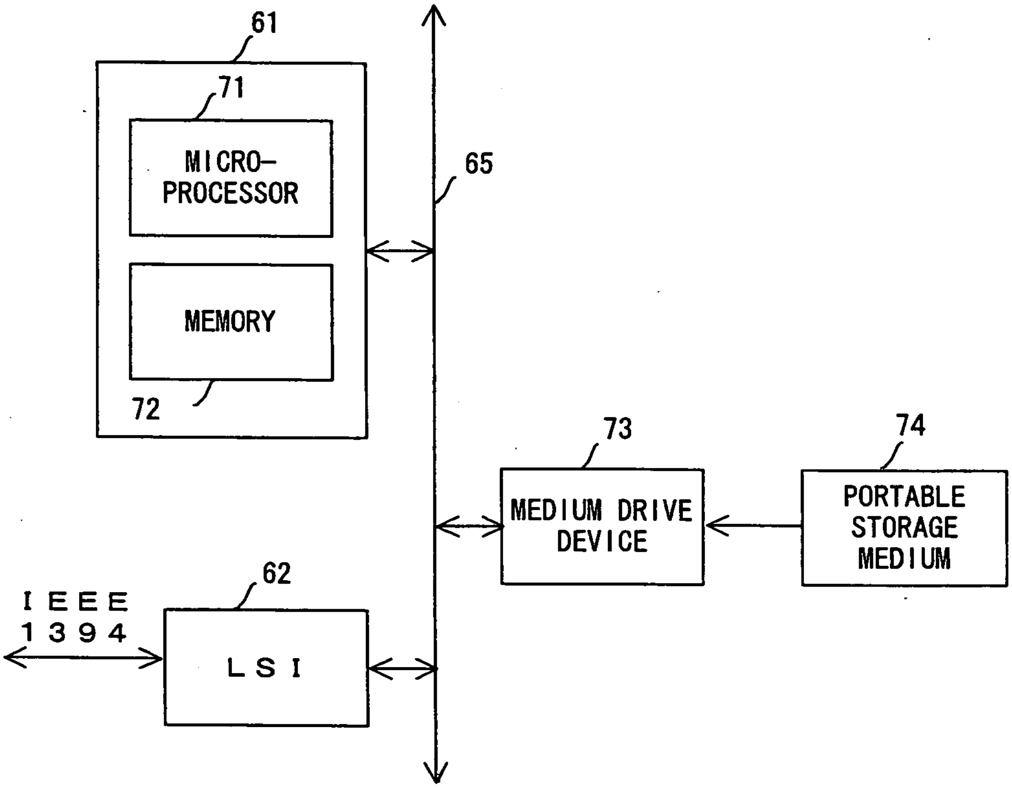

61
71
MICRO-PROCESSOR
MEMORY
72
65
73
MEDIUM DRIVE DEVICE
74
PORTABLE STORAGE MEDIUM
62
IEEE 1394
LSI

FIG. 30

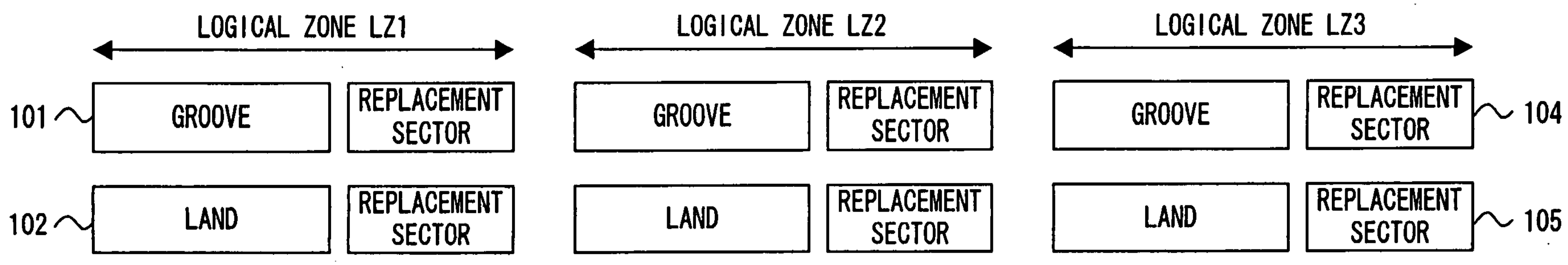

LOGICAL ZONE LZ1
LOGICAL ZONE LZ2
LOGICAL ZONE LZ3
101
102
104
105
GROOVE
REPLACEMENT SECTOR
LAND
REPLACEMENT SECTOR
GROOVE
REPLACEMENT SECTOR
LAND
REPLACEMENT SECTOR
GROOVE
REPLACEMENT SECTOR
LAND
REPLACEMENT SECTOR

FIG. 31

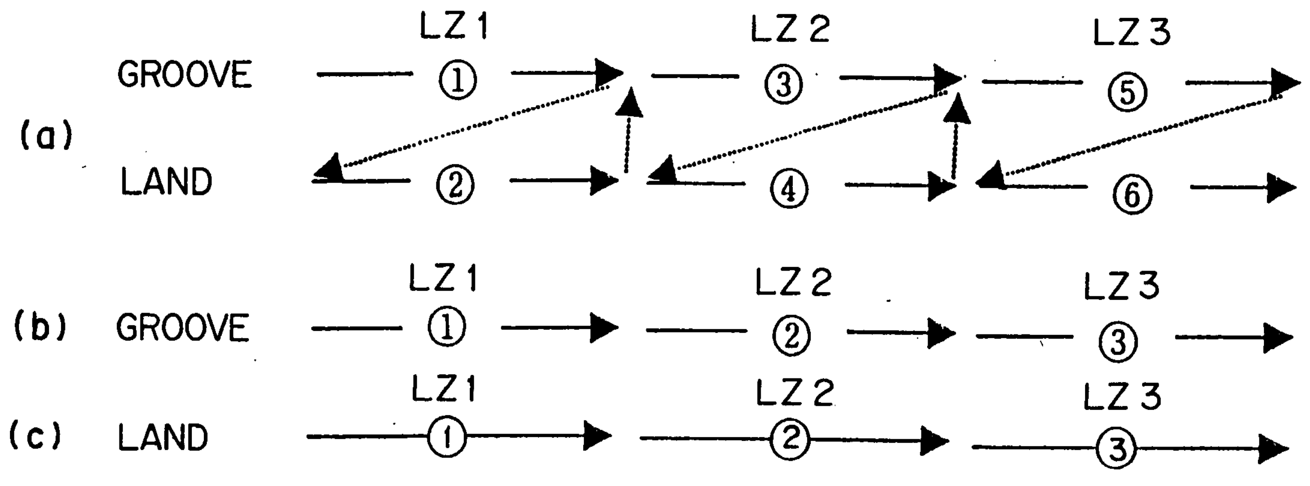

(a)
GROOVE
LAND
LZ1
LZ2
LZ3
①
②
③
④
⑤
⑥
(b)
GROOVE
LZ1
LZ2
LZ3
①
②
③
(c)
LAND
LZ1
LZ2
LZ3
①
②
③

FIG. 32

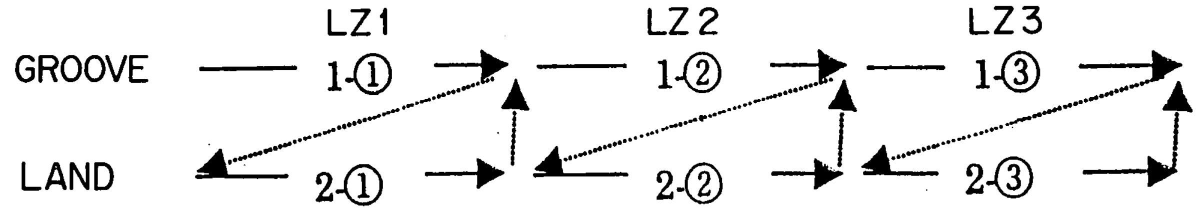


FIG. 33

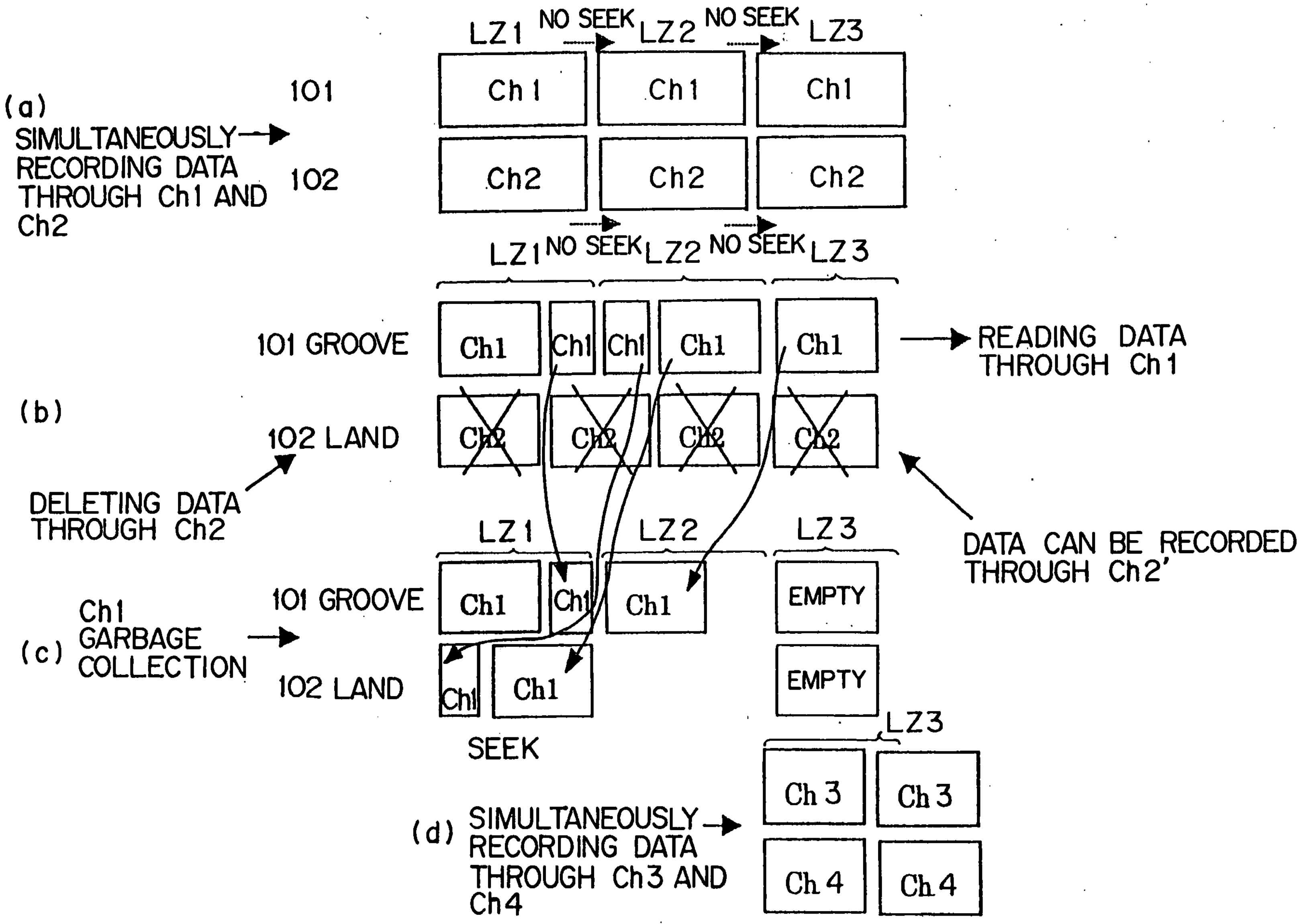

(a)
SIMULTANEOUSLY RECORDING DATA THROUGH Ch1 AND Ch2
101
102
LZ1
NO SEEK
LZ2
NO SEEK
LZ3
Ch1
Ch1
Ch1
Ch2
Ch2
Ch2
NO SEEK
NO SEEK
(b)
LZ1
LZ2
LZ3
101 GROOVE
Ch1
Ch1
Ch1
Ch1
Ch1
READING DATA THROUGH Ch1
102 LAND
Ch2
Ch2
Ch2
Ch2
DELETING DATA THROUGH Ch2
DATA CAN BE RECORDED THROUGH Ch2'
(c)
Ch1 GARBAGE COLLECTION
LZ1
LZ2
LZ3
101 GROOVE
Ch1
Ch1
Ch1
EMPTY
102 LAND
Ch1
Ch1
EMPTY
SEEK
(d)
SIMULTANEOUSLY RECORDING DATA THROUGH Ch3 AND Ch4
LZ3
Ch 3
Ch 3
Ch 4
Ch 4

FIG. 34

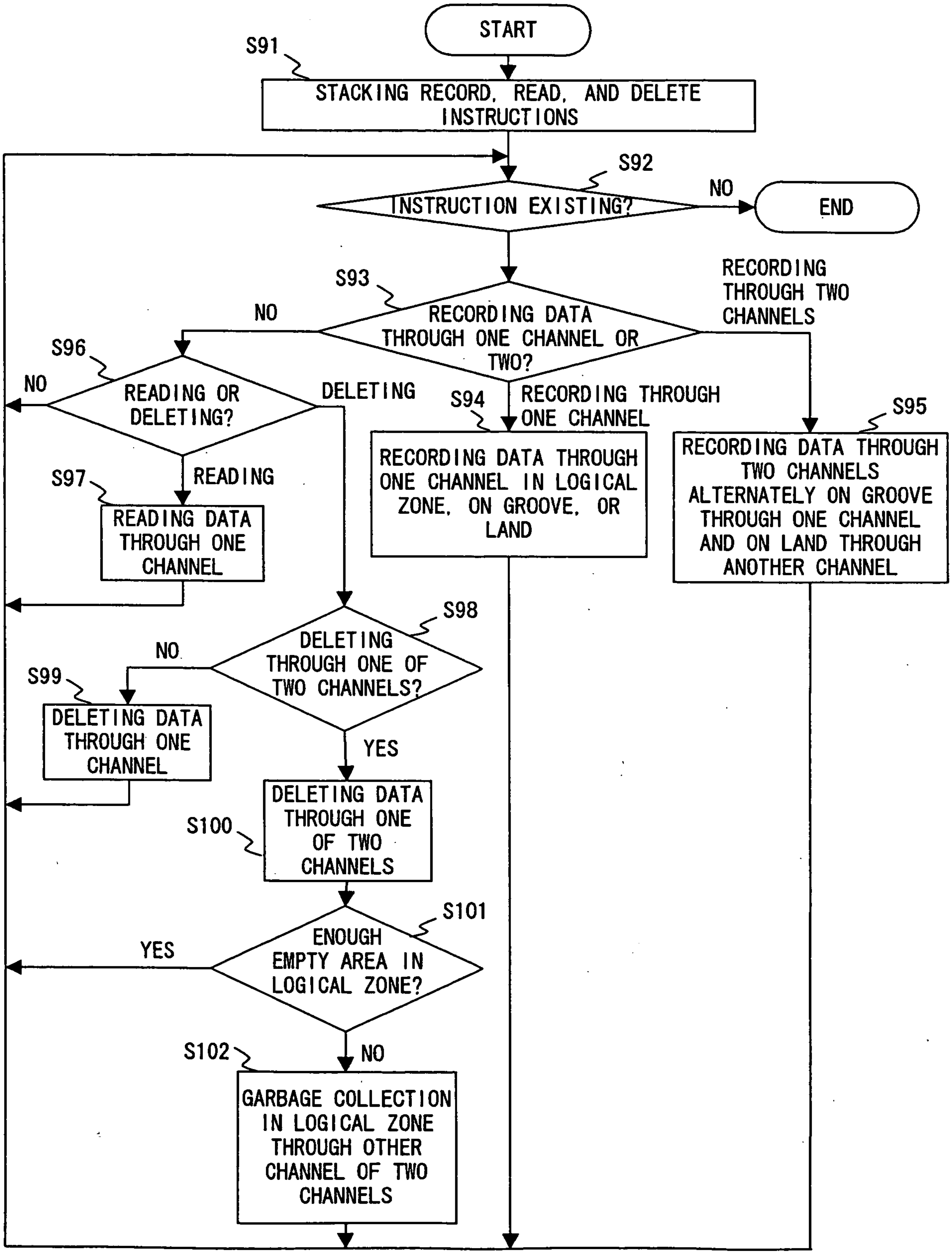

START
S91
STACKING RECORD, READ, AND DELETE INSTRUCTIONS
S92
INSTRUCTION EXISTING?
NO
END
S93
RECORDING DATA THROUGH ONE CHANNEL OR TWO?
NO
RECORDING THROUGH TWO CHANNELS
S96
READING OR DELETING?
NO
DELETING
S94
RECORDING THROUGH ONE CHANNEL
S95
RECORDING DATA THROUGH ONE CHANNEL IN LOGICAL ZONE, ON GROOVE, OR LAND
RECORDING DATA THROUGH TWO CHANNELS ALTERNATELY ON GROOVE THROUGH ONE CHANNEL AND ON LAND THROUGH ANOTHER CHANNEL
S97
READING
READING DATA THROUGH ONE CHANNEL
S98
DELETING THROUGH ONE OF TWO CHANNELS?
NO
S99
DELETING DATA THROUGH ONE CHANNEL
YES
S100
DELETING DATA THROUGH ONE OF TWO CHANNELS
S101
ENOUGH EMPTY AREA IN LOGICAL ZONE?
YES
S102
NO
GARBAGE COLLECTION IN LOGICAL ZONE THROUGH OTHER CHANNEL OF TWO CHANNELS

FIG. 35

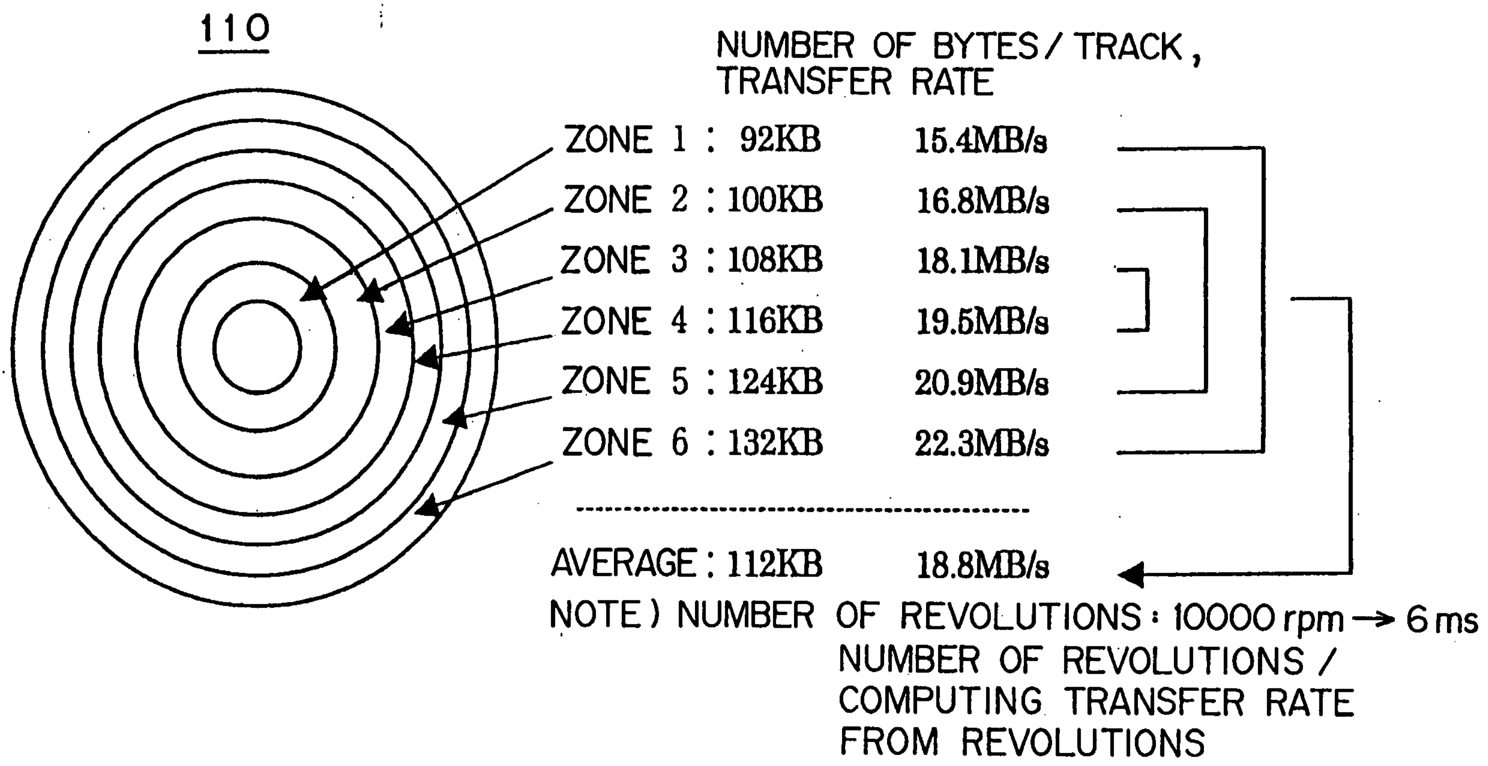

110
NUMBER OF BYTES / TRACK, TRANSFER RATE
ZONE 1 : 92KB 15.4MB/s
ZONE 2 : 100KB 16.8MB/s
ZONE 3 : 108KB 18.1MB/s
ZONE 4 : 116KB 19.5MB/s
ZONE 5 : 124KB 20.9MB/s
ZONE 6 : 132KB 22.3MB/s
AVERAGE : 112KB 18.8MB/s
NOTE) NUMBER OF REVOLUTIONS : 10000 rpm → 6 ms
NUMBER OF REVOLUTIONS / COMPUTING TRANSFER RATE FROM REVOLUTIONS

FIG. 36

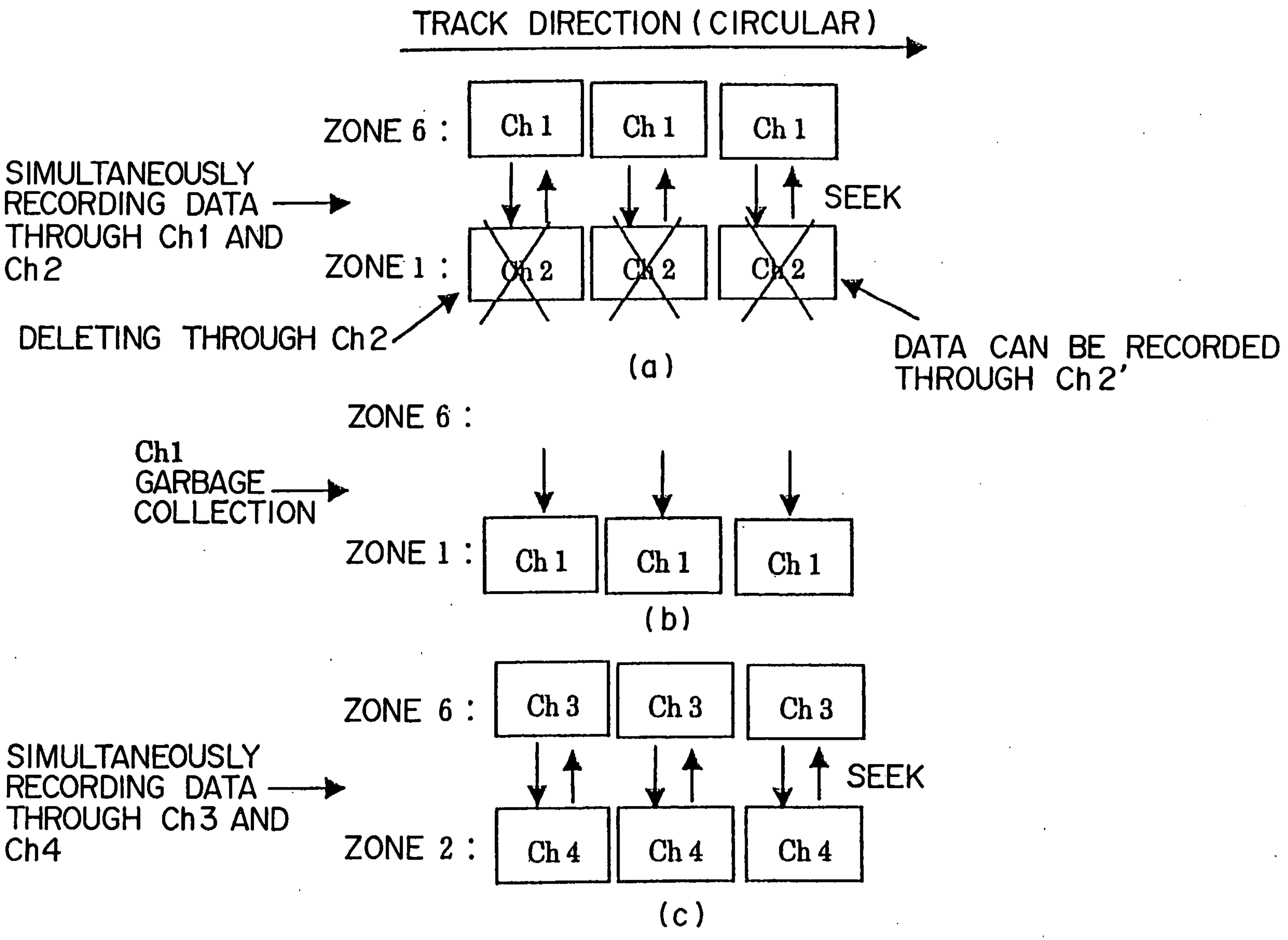

TRACK DIRECTION (CIRCULAR)
ZONE 6 :
Ch 1
Ch 1
Ch 1
SIMULTANEOUSLY RECORDING DATA THROUGH Ch1 AND Ch2
SEEK
ZONE 1 :
Ch 2
Ch 2
Ch 2
DELETING THROUGH Ch2
DATA CAN BE RECORDED THROUGH Ch2'
(a)
ZONE 6 :
Ch1 GARBAGE COLLECTION
ZONE 1 :
Ch 1
Ch 1
Ch 1
(b)
ZONE 6 :
Ch 3
Ch 3
Ch 3
SIMULTANEOUSLY RECORDING DATA THROUGH Ch3 AND Ch4
SEEK
ZONE 2 :
Ch 4
Ch 4
Ch 4
(c)

FIG. 37

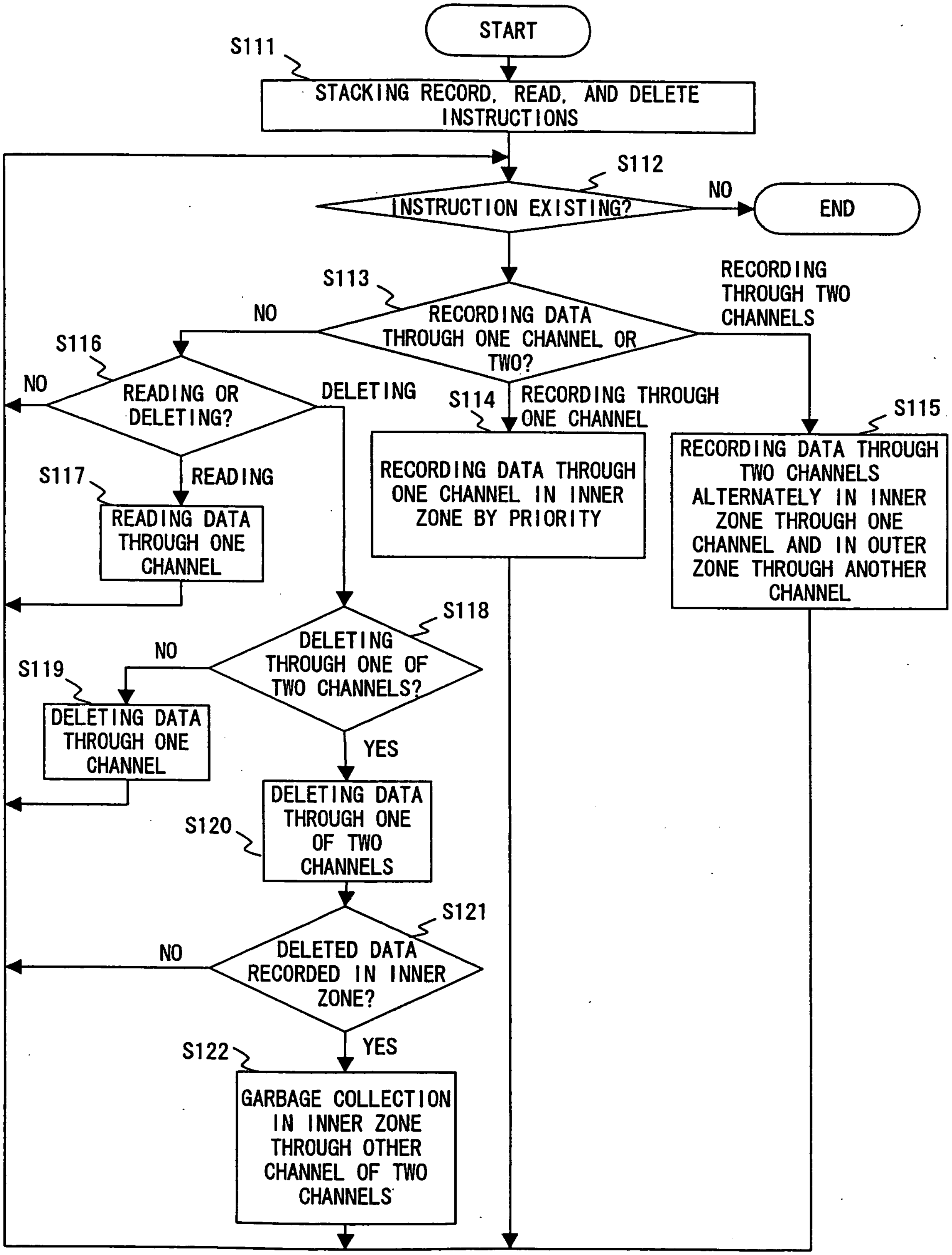

START
S111
STACKING RECORD, READ, AND DELETE INSTRUCTIONS
S112
INSTRUCTION EXISTING?
NO
END
S113
RECORDING DATA THROUGH ONE CHANNEL OR TWO?
NO
RECORDING THROUGH TWO CHANNELS
RECORDING THROUGH ONE CHANNEL
S114
RECORDING DATA THROUGH ONE CHANNEL IN INNER ZONE BY PRIORITY
S115
RECORDING DATA THROUGH TWO CHANNELS ALTERNATELY IN INNER ZONE THROUGH ONE CHANNEL AND IN OUTER ZONE THROUGH ANOTHER CHANNEL
S116
READING OR DELETING?
NO
DELETING
READING
S117
READING DATA THROUGH ONE CHANNEL
S118
DELETING THROUGH ONE OF TWO CHANNELS?
NO
YES
S119
DELETING DATA THROUGH ONE CHANNEL
S120
DELETING DATA THROUGH ONE OF TWO CHANNELS
S121
DELETED DATA RECORDED IN INNER ZONE?
NO
YES
S122
GARBAGE COLLECTION IN INNER ZONE THROUGH OTHER CHANNEL OF TWO CHANNELS

FIG. 38

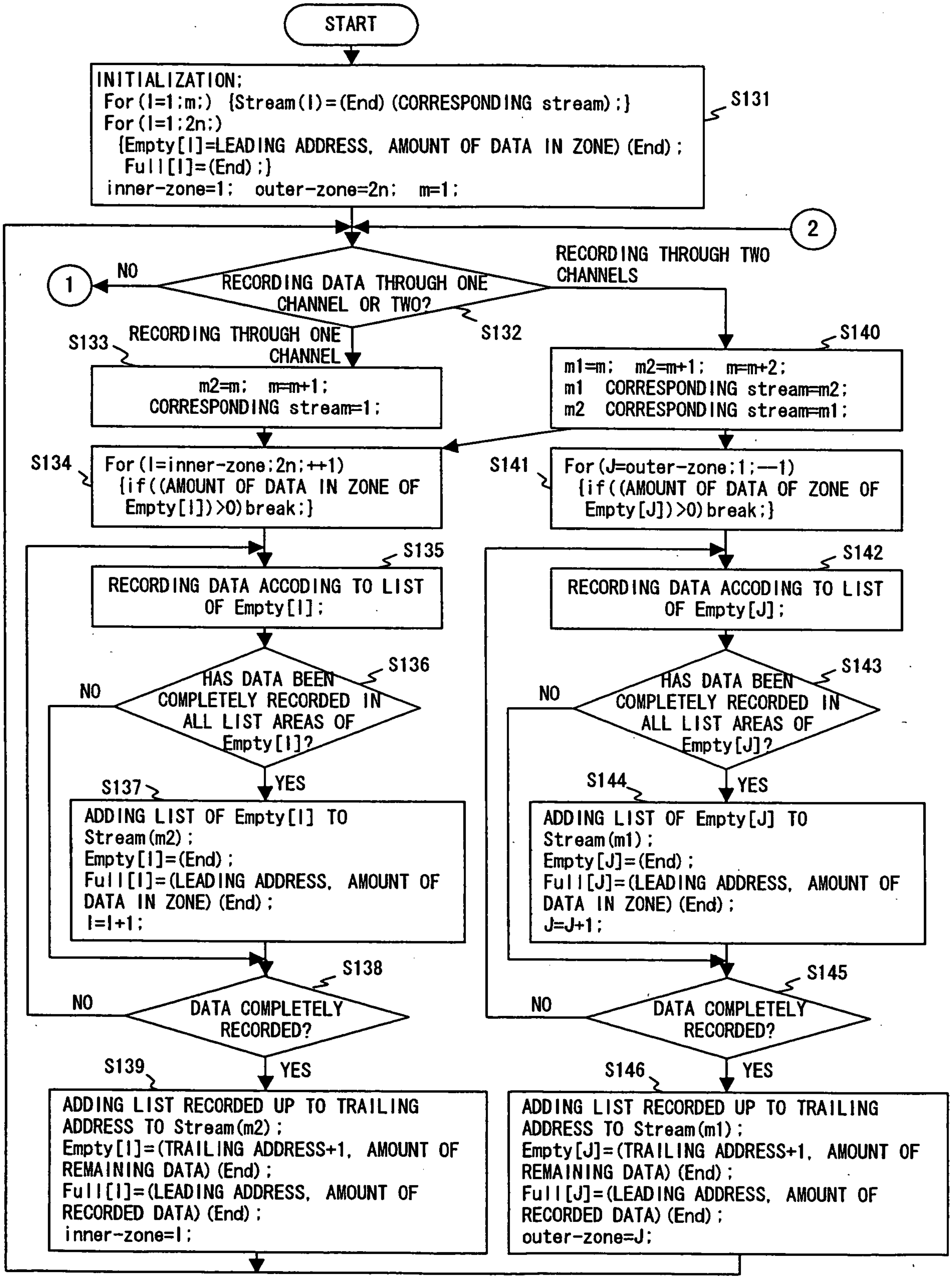

START
INITIALIZATION;
For(I=1;m;) {Stream(I)=(End) (CORRESPONDING stream);}
For(I=1;2n;)
{Empty[I]=LEADING ADDRESS, AMOUNT OF DATA IN ZONE) (End);
Full[I]=(End);}
inner-zone=1; outer-zone=2n; m=1;
S131
2
RECORDING DATA THROUGH ONE CHANNEL OR TWO?
S132
NO
1
RECORDING THROUGH TWO CHANNELS
RECORDING THROUGH ONE CHANNEL
S133
m2=m; m=m+1;
CORRESPONDING stream=1;
S140
m1=m; m2=m+1; m=m+2;
m1 CORRESPONDING stream=m2;
m2 CORRESPONDING stream=m1;
S134
For(I=inner-zone;2n;++1)
{if((AMOUNT OF DATA IN ZONE OF Empty[I])>0)break;}
S141
For(J=outer-zone;1;—1)
{if((AMOUNT OF DATA OF ZONE OF Empty[J])>0)break;}
S135
RECORDING DATA ACCODING TO LIST OF Empty[I];
S142
RECORDING DATA ACCODING TO LIST OF Empty[J];
S136
HAS DATA BEEN COMPLETELY RECORDED IN ALL LIST AREAS OF Empty[I]?
NO
YES
S143
HAS DATA BEEN COMPLETELY RECORDED IN ALL LIST AREAS OF Empty[J]?
NO
YES
S137
ADDING LIST OF Empty[I] TO Stream(m2);
Empty[I]=(End);
Full[I]=(LEADING ADDRESS, AMOUNT OF DATA IN ZONE) (End);
I=I+1;
S144
ADDING LIST OF Empty[J] TO Stream(m1);
Empty[J]=(End);
Full[J]=(LEADING ADDRESS, AMOUNT OF DATA IN ZONE) (End);
J=J+1;
S138
DATA COMPLETELY RECORDED?
NO
YES
S145
DATA COMPLETELY RECORDED?
NO
YES
S139
ADDING LIST RECORDED UP TO TRAILING ADDRESS TO Stream(m2);
Empty[I]=(TRAILING ADDRESS+1, AMOUNT OF REMAINING DATA) (End);
Full[I]=(LEADING ADDRESS, AMOUNT OF RECORDED DATA) (End);
inner-zone=I;
S146
ADDING LIST RECORDED UP TO TRAILING ADDRESS TO Stream(m1);
Empty[J]=(TRAILING ADDRESS+1, AMOUNT OF REMAINING DATA) (End);
Full[J]=(LEADING ADDRESS, AMOUNT OF RECORDED DATA) (End);
outer-zone=J;

FIG. 39

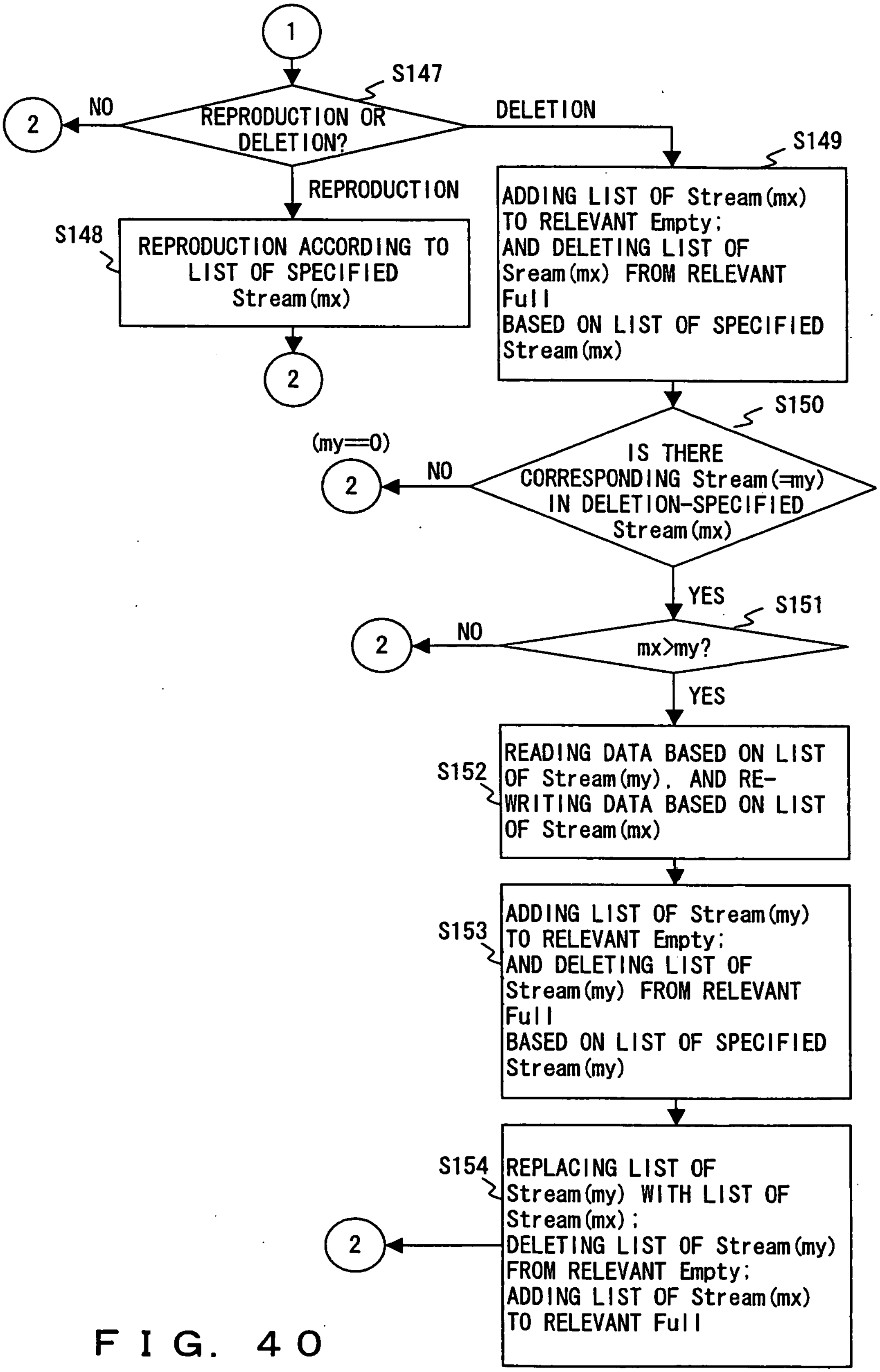

1
S147
REPRODUCTION OR DELETION?
NO
2
DELETION
REPRODUCTION
S148
REPRODUCTION ACCORDING TO LIST OF SPECIFIED Stream(mx)
2
S149
ADDING LIST OF Stream(mx) TO RELEVANT Empty;
AND DELETING LIST OF Sream(mx) FROM RELEVANT Full
BASED ON LIST OF SPECIFIED Stream(mx)
S150
IS THERE CORRESPONDING Stream(=my) IN DELETION-SPECIFIED Stream(mx)
(my==0)
NO
2
YES
S151
mx>my?
NO
2
YES
S152
READING DATA BASED ON LIST OF Stream(my), AND RE-WRITING DATA BASED ON LIST OF Stream(mx)
S153
ADDING LIST OF Stream(my) TO RELEVANT Empty;
AND DELETING LIST OF Stream(my) FROM RELEVANT Full
BASED ON LIST OF SPECIFIED Stream(my)
S154
REPLACING LIST OF Stream(my) WITH LIST OF Stream(mx);
DELETING LIST OF Stream(my) FROM RELEVANT Empty;
ADDING LIST OF Stream(mx) TO RELEVANT Full
2

FIG. 40

120

STREAM LIST	(LEADING ADDRESS, AMOUNT OF DATA) → COMPLETION, CORRESPONDING stream FOR RECORDING DATA THROUGH TWO CHANNELS
Stream(1)	(Add, Data) → (Add, Data) →···→ End.m?
⋮	⋮
Stream(m)	(Add, Data) → (Add, Data) →···→ End.m?

FIG. 41

130

INNER/ OUTER	ZONE	EMPTY/FULL LIST	(LEADING ADDRESS, AMOUNT OF DATA) → COMPLETION : LIST STRUCTURE
INNER ZONE	1	Empty[1]	(Add, Data) → (Add, Data) →···→ End
		Full[1]	(Add, Data) → (Add, Data) →···→ End
	⋮	⋮	⋮
	n	Empty[n]	(Add, Data) → End (INITIAL VALUE)
		Full[n]	End (INITIAL VALUE)
OUTER ZONE	n+1	Empty[n+1]	(Add, Data) → End (INITIAL VALUE)
		Full[n+1]	End (INITIAL VALUE)
	⋮	⋮	⋮
	2n	Empty[2n]	(Add, Data) → (Add, Data) →···→ End
		Full[2n]	(Add, Data) → (Add, Data) →···→ End

F I G. 4 2

ZONE no.	NUMBER OF BYTES/TRACK	NUMBER OF TRACKS	NUMBER OF SECTORS	SECTOR ADDRESS
1	92KB	1000	184k	1-184000
2	100KB	1000	200k	184000-384000
3	108KB	1000	216k	384001-600000
4	116KB	1000	232k	600001-832000
5	124KB	1000	248k	832001-1080000
6	132KB	1000	264k	1080001-1344000

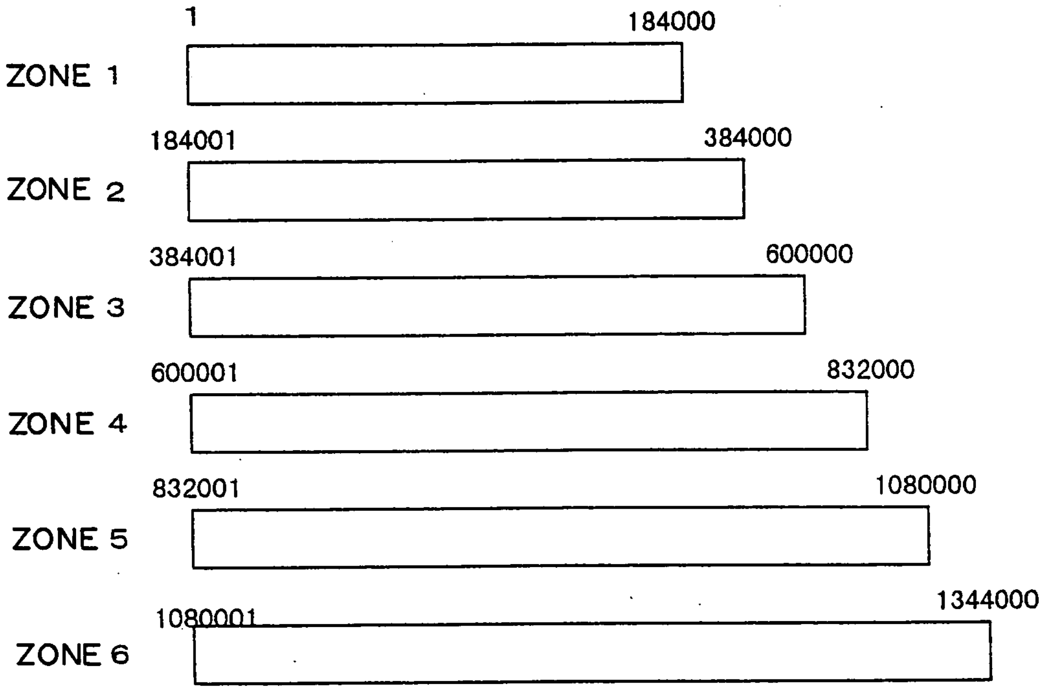
*: 512B/SECTOR

FIG. 43

150

	STORAGE ADDRESS	MEANING OF INFORMATION	STORED DATA (LEADING STORAGE DEVICE, AMOUNT OF DATA, NEXT STORAGE ADDRESS)
INITIALIZED AREA 151	0	End	(0, 0, 0)
120	1	Stream(1)	① (0, 0, 0) ③→ (1080001, 264000, 19) ⑤→ (1, 184000, 20)
	2	Stream(2)	① (0, 0, 0) ②→ (1, 184000, 18) ④→ (0, 0, 0)
	3	Stream(3)	① (0, 0, 0) ⑦→ (1080001, 256000, 22)
	4	Stream(4)	① (0, 0, 0) ⑥→ (300001, 84000, 21)
	5	Stream(5)	① (0, 0, 0)
130	6	Empty[1]	① (1, 184000, 0) ②→ (0, 0, 0) ④→ (1, 184000, 0) ⑤→ (0, 0, 0)
	7	Empty[2]	① (184001, 200000, 0) ③→ (300001, 84000. 0) ④→ (184001, 200000, 0) ⑤→ (300001, 84000, 0) ⑥→ (0, 0, 0)
	8	Empty[3]	① (384001, 216000, 0) ⑦→ (0, 0, 0)
	9	Empty[4]	① (600001, 232000, 0)
	10	Empty[5]	① (832001, 248000, 0 ③→ (876001, 204000, 0) ⑤→ (832001, 248000. 0) ⑦→ (876001, 204000, 0)
	11	Empty[6]	① (1080001, 256000, 0) ③→ (0, 0, 0) ⑤→ (1080001, 256000, 0) ⑦→ (0, 0, 0)
	12	Full[1]	① (1, 0, 0) ②→ (1, 184000, 0) ④→ (1, 0, 0) ⑤→ (1, 184000, 0)
	13	Full[2]	① (184001, 0, 0) ③→ (184001, 116000, 0) ④→ (184001, 0, 0) ⑤→ (184001, 11600, 0) ⑥→ (184001, 200000, 0)
	14	Full[3]	① (384001, 0, 0) ⑦→ (384001, 216000, 0)
	15	Full[4]	① (600001, 0, 0)
	16	Full[5]	① (832001, 0, 0) ③→ (832001, 44000, 0) ⑤→ (832001, 0, 0) ⑦→ (832001, 44000, 0)
	17	Full[6]	① (1080001, 0, 0) ③→ (1080001, 256000, 0) ⑥→ (1080001, 84001, 0) ⑦→ (1080001, 256000, 0)
EXTENSION AREA 152	18	$Z_1 \to Z_2$	(184001, 0, 0) ③→ (184001, 116000, 0)
	19	$Z_6 \to Z_5$	(832001, 0, 0) ③→ (832001, 44000, 0)
	20	$Z_1 \to Z_2$	(184001, 0, 0) ⑤→ (184001, 116000, 0)
	21	$Z_2 \to Z_3$	(384001, 0, 0) ⑦→ (384001, 216000, 0)
	22	$Z_6 \to Z_5$	(832001, 0, 0) ⑦→ (832001, 44000, 0)
	23		
	24		
	25		
	26		
	27		

FIG. 44



(1) INITIALIZATION STATUS

FIG. 45

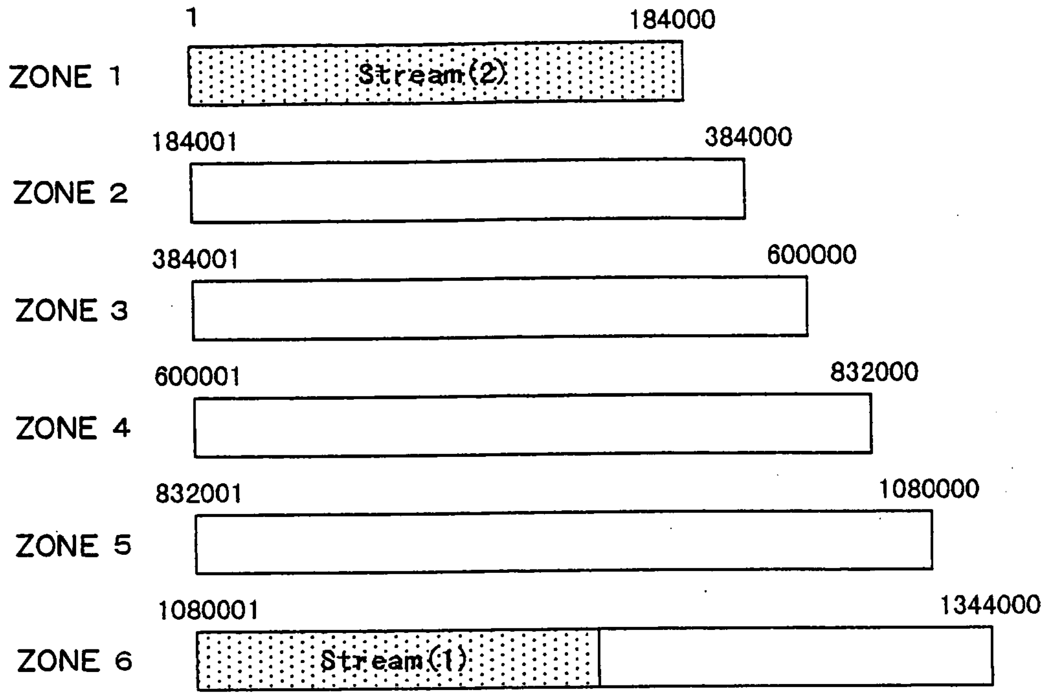

ZONE 1
1
184000
Stream(2)
ZONE 2
184001
384000
ZONE 3
384001
600000
ZONE 4
600001
832000
ZONE 5
832001
1080000
ZONE 6
1080001
1344000
Stream(1)

FIG. 46

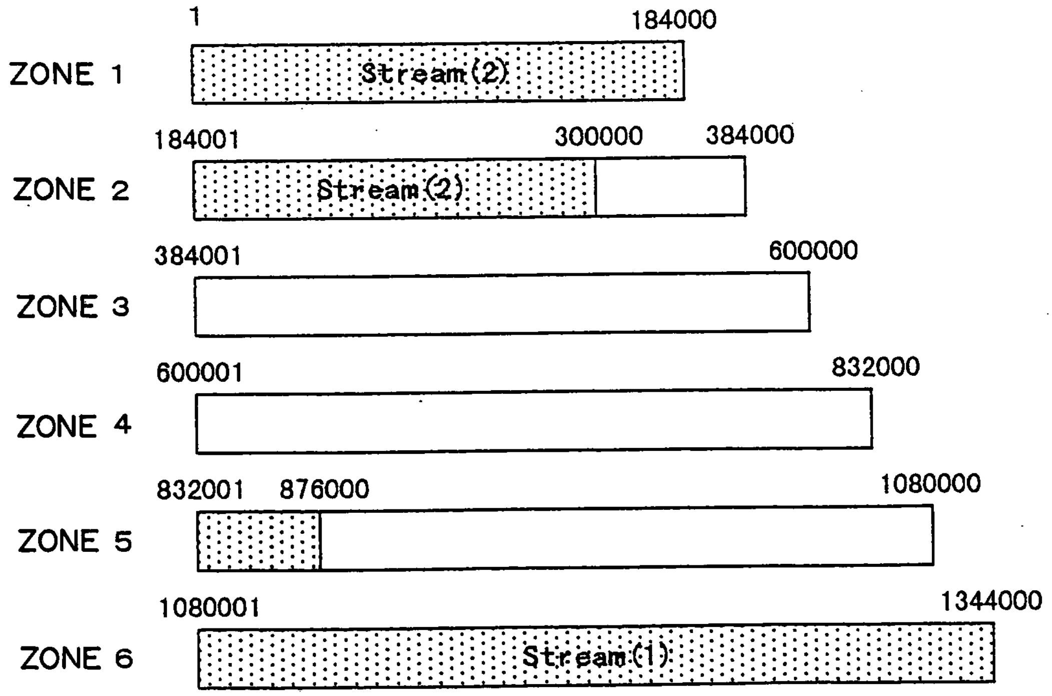
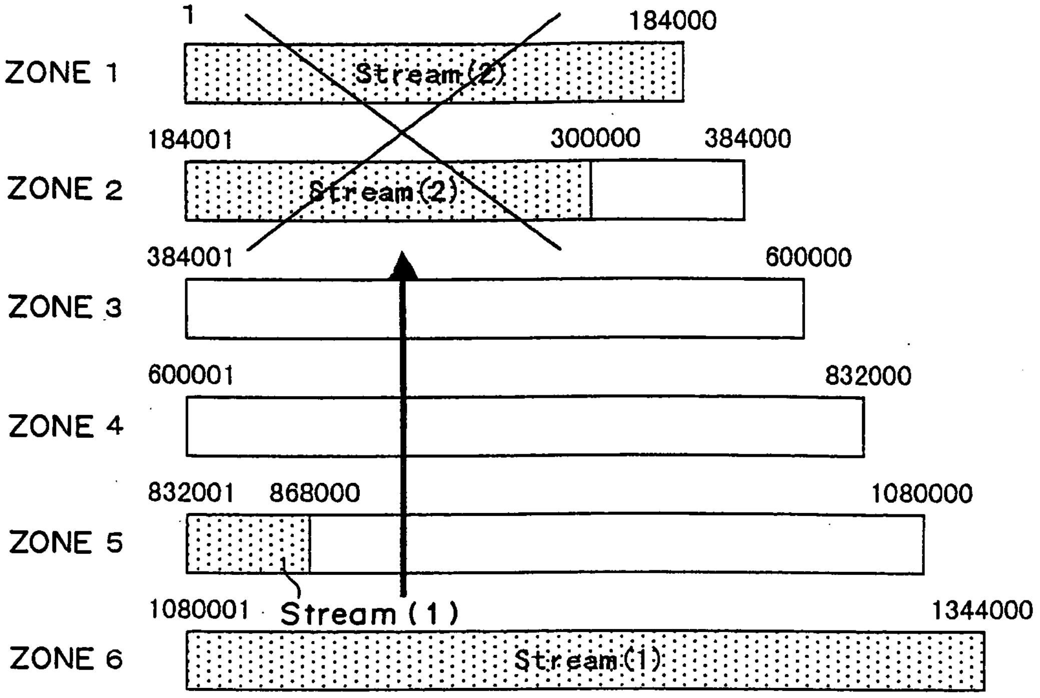
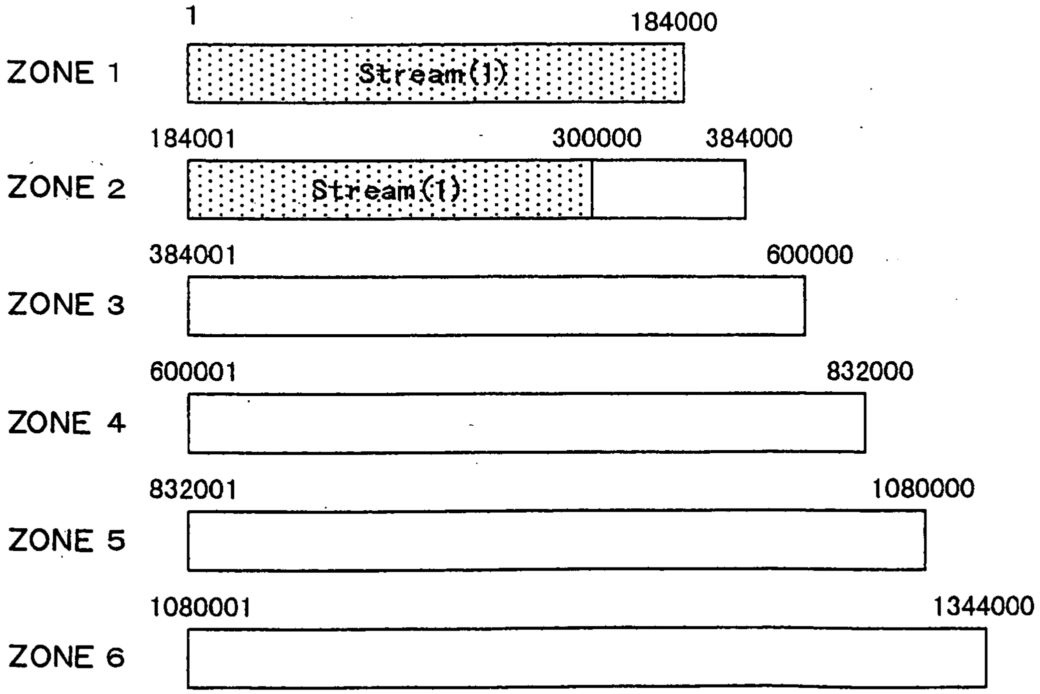

ZONE 1
1
184000
Stream(2)
ZONE 2
184001
300000
384000
Stream(2)
ZONE 3
384001
600000
ZONE 4
600001
832000
ZONE 5
832001
876000
1080000
ZONE 6
1080001
1344000
Stream(1)

FIG. 47



1
184000
ZONE 1
Stream(2)
184001
300000
384000
ZONE 2
Stream(2)
384001
600000
ZONE 3
600001
832000
ZONE 4
832001
868000
1080000
ZONE 5
Stream (1)
1080001
1344000
ZONE 6
Stream(1)

FIG. 48



1
184000
ZONE 1
Stream(1)
184001
300000
384000
ZONE 2
Stream(1)
384001
600000
ZONE 3
600001
832000
ZONE 4
832001
1080000
ZONE 5
1080001
1344000
ZONE 6

FIG. 49

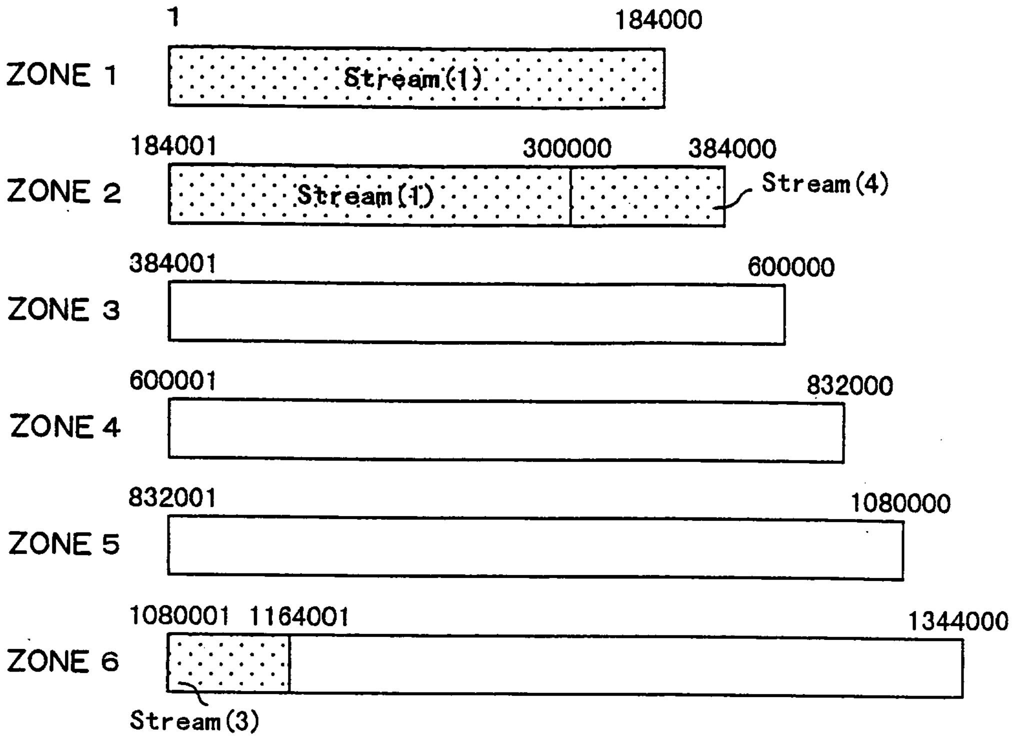

1
184000
ZONE 1
Stream (1)
184001
300000
384000
ZONE 2
Stream (1)
Stream (4)
384001
600000
ZONE 3
600001
832000
ZONE 4
832001
1080000
ZONE 5
1080001
1164001
1344000
ZONE 6
Stream (3)

FIG. 50

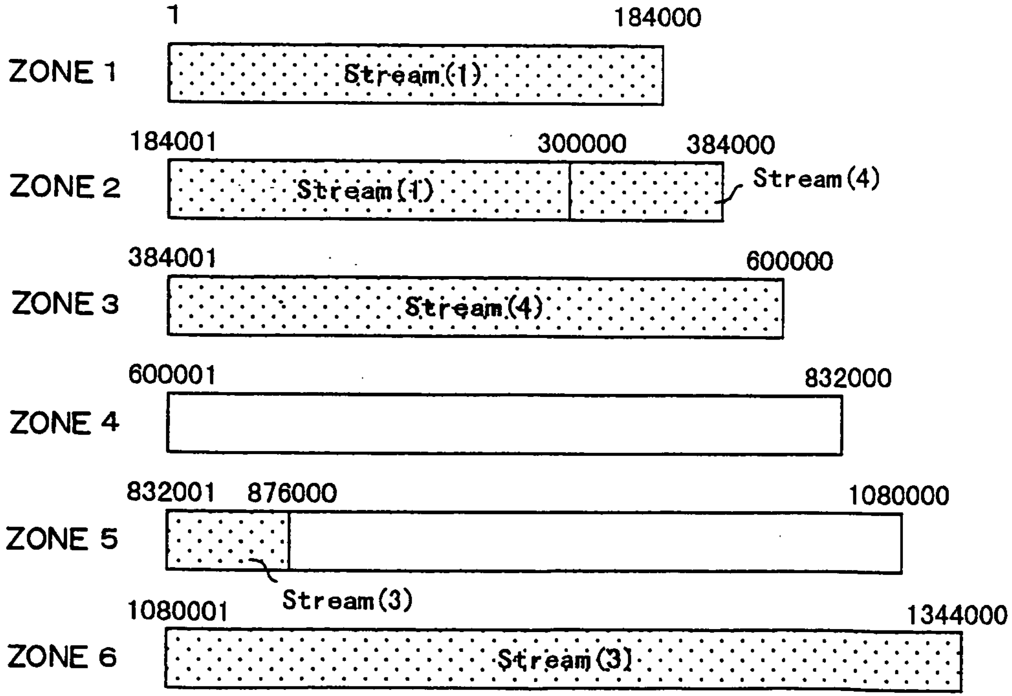
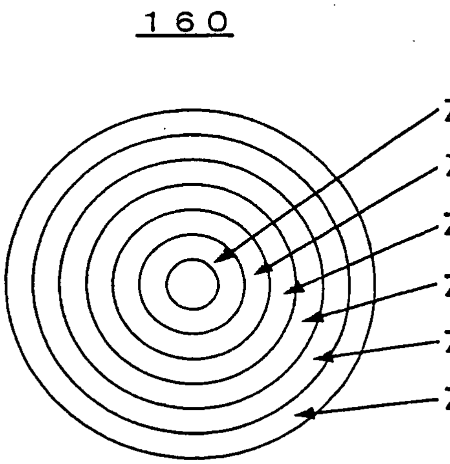

1
184000
ZONE 1
Stream (1)
184001
300000
384000
ZONE 2
Stream (1)
Stream (4)
384001
600000
ZONE 3
Stream (4)
600001
832000
ZONE 4
832001
876000
1080000
ZONE 5
Stream (3)
1080001
1344000
ZONE 6
Stream (3)

FIG. 51



NUMBER OF BYTES / TRACK,
TRANSFER RATE

ZONE 1 :	70KB	17.54 Mbps
ZONE 2 :	80KB	20 Mbps
ZONE 3 :	90KB	22.5 Mbps
ZONE 4 :	100KB	25 Mbps
ZONE 5 :	110KB	27.5 Mbps
ZONE 6 :	120KB	30 Mbps

FIG. 52

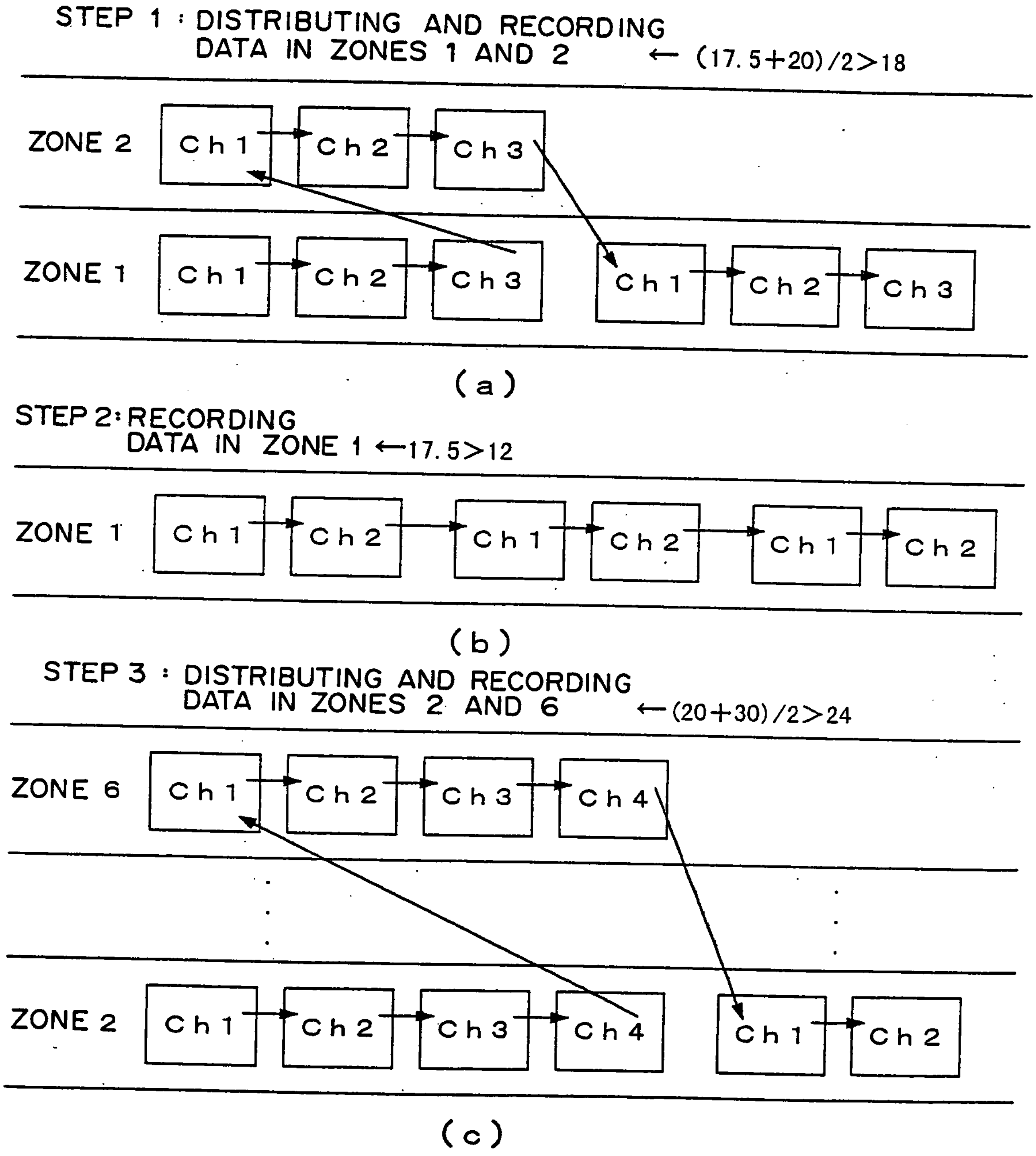
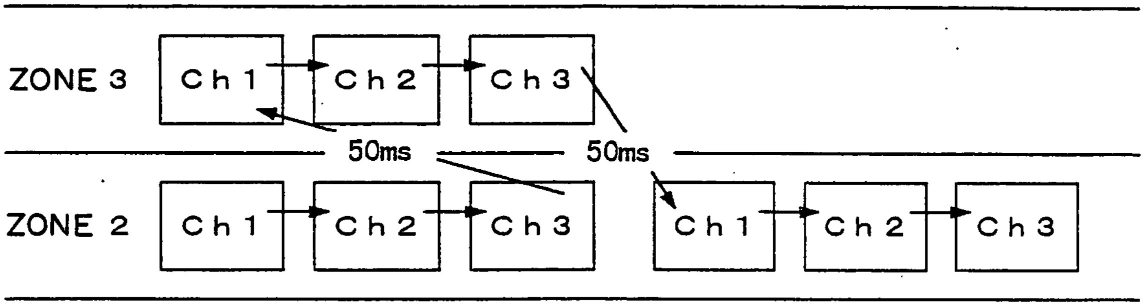

STEP 1 : DISTRIBUTING AND RECORDING DATA IN ZONES 1 AND 2
← (17.5+20)/2>18
ZONE 2
Ch 1
Ch 2
Ch 3
ZONE 1
Ch 1
Ch 2
Ch 3
Ch 1
Ch 2
Ch 3
(a)
STEP 2 : RECORDING DATA IN ZONE 1
←17.5>12
ZONE 1
Ch 1
Ch 2
Ch 1
Ch 2
Ch 1
Ch 2
(b)
STEP 3 : DISTRIBUTING AND RECORDING DATA IN ZONES 2 AND 6
←(20+30)/2>24
ZONE 6
Ch 1
Ch 2
Ch 3
Ch 4
ZONE 2
Ch 1
Ch 2
Ch 3
Ch 4
Ch 1
Ch 2
(c)

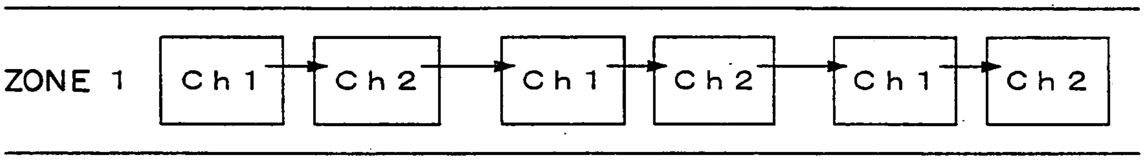
FIG. 53

STEP 1 : DISTRIBUTING AND RECORDING
DATA IN ZONES 2 AND 3 ← (20+22.5) ×0.9/2>18



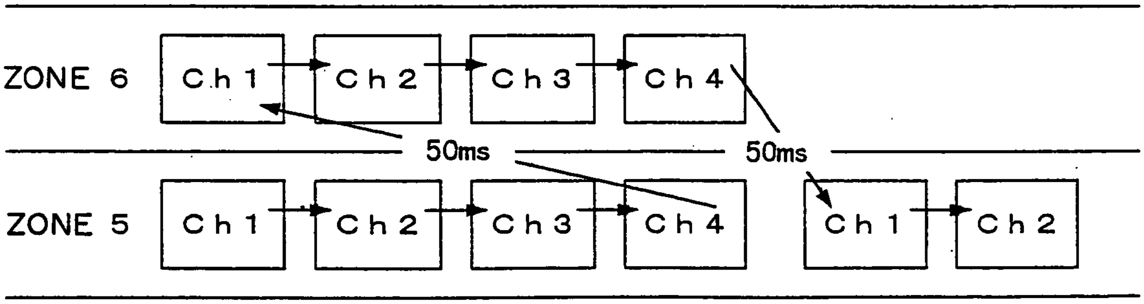
(a)

STEP 2 : RECORDING
DATA IN ZONE 1 ←17.5>12



(b)

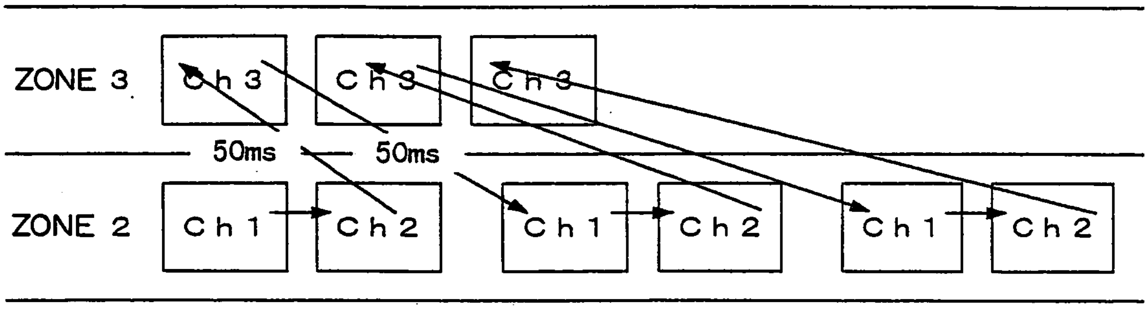
STEP 3 : DISTRIBUTING AND RECORDING
DATA IN ZONE 5 AND 6 ←(27.5+30) ×0.9/2>24



(c)

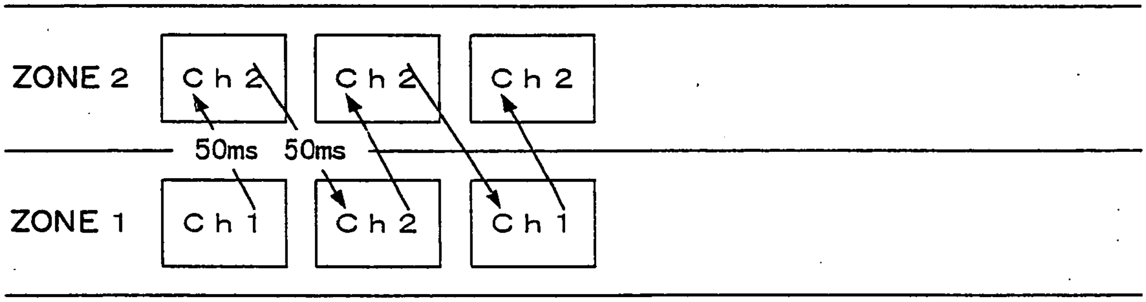
FIG. 54

STEP 1 : DISTRIBUTING AND RECORDING
DATA IN ZONES 2 AND 3 ← $(20+2/3+22.5\times 1/3)\times 0.9>18$
DISTRIBUTING DATA ALTERNATELY THROUGH 1ch AND 2ch



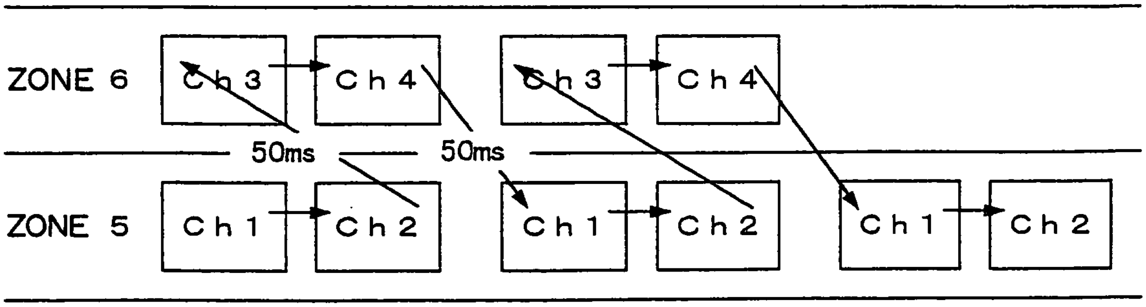
(a)

STEP 2 : RECORDING DATA
IN ZONES 1 AND 2 ← $17.5/2+20/2)\times 0.9>12$



(b)

STEP 3 : DISTRIBUTING AND RECORDING
DATA IN ZONES 5 AND 6 ← $(27.5\times 2/4+30\times 2/4)\times 0.9>24$
ALTERNATELY DISTRIBUTING DATA IN TWO CHANNEL UNITS



(c)

FIG. 55

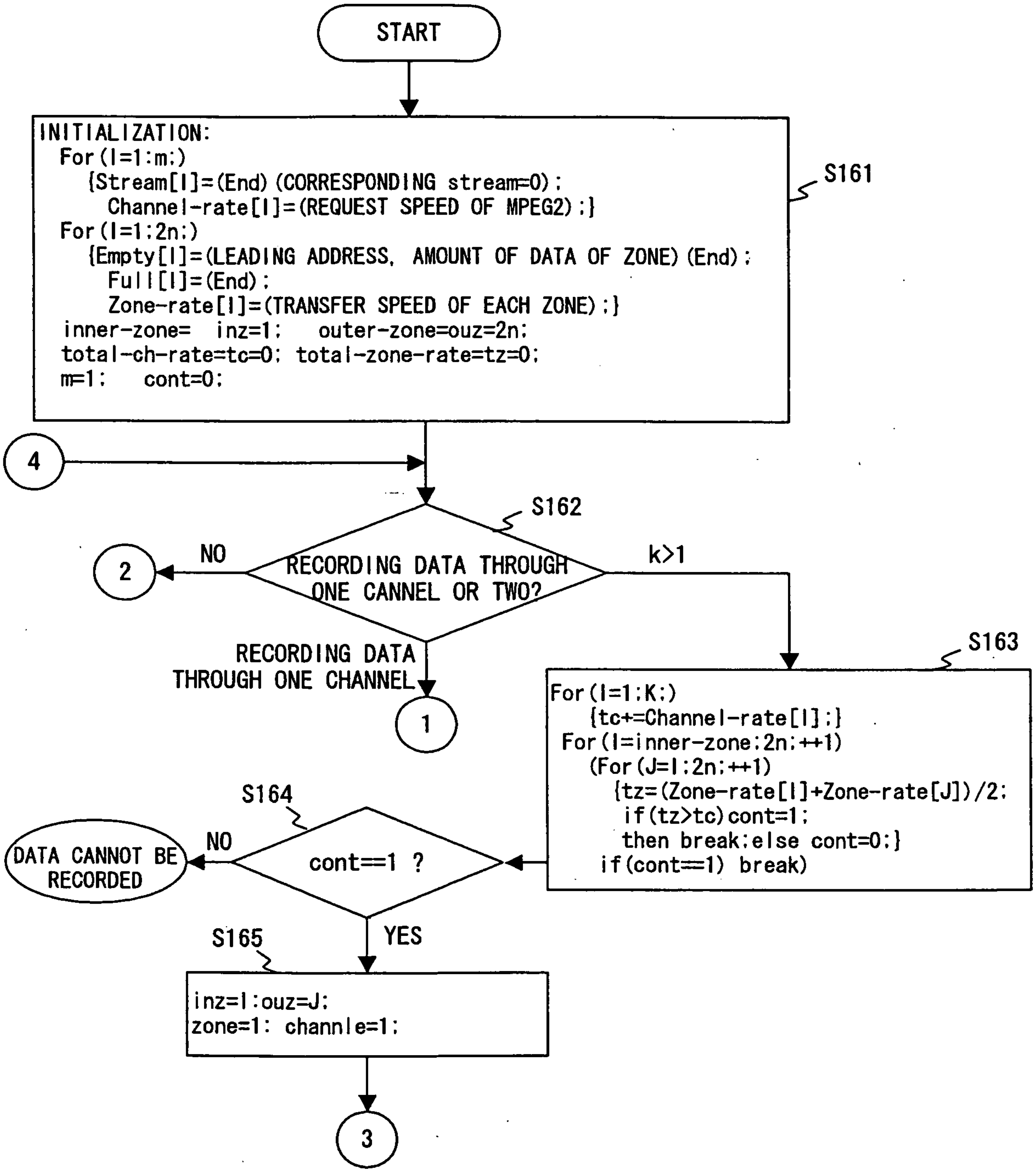

START
INITIALIZATION:
For(I=1:m:)
{Stream[I]=(End)(CORRESPONDING stream=0);
Channel-rate[I]=(REQUEST SPEED OF MPEG2);}
For(I=1:2n:)
{Empty[I]=(LEADING ADDRESS, AMOUNT OF DATA OF ZONE)(End);
Full[I]=(End);
Zone-rate[I]=(TRANSFER SPEED OF EACH ZONE);}
inner-zone= inz=1; outer-zone=ouz=2n;
total-ch-rate=tc=0; total-zone-rate=tz=0;
m=1; cont=0;
S161
4
S162
RECORDING DATA THROUGH ONE CANNEL OR TWO?
NO
2
k>1
RECORDING DATA THROUGH ONE CHANNEL
1
S163
For(I=1;K;)
{tc+=Channel-rate[I];}
For(I=inner-zone;2n;++1)
(For(J=I;2n;++1)
{tz=(Zone-rate[I]+Zone-rate[J])/2;
if(tz>tc)cont=1;
then break;else cont=0;}
if(cont==1) break)
S164
cont==1 ?
NO
DATA CANNOT BE RECORDED
YES
S165
inz=I:ouz=J;
zone=1: channle=1;
3

FIG. 56

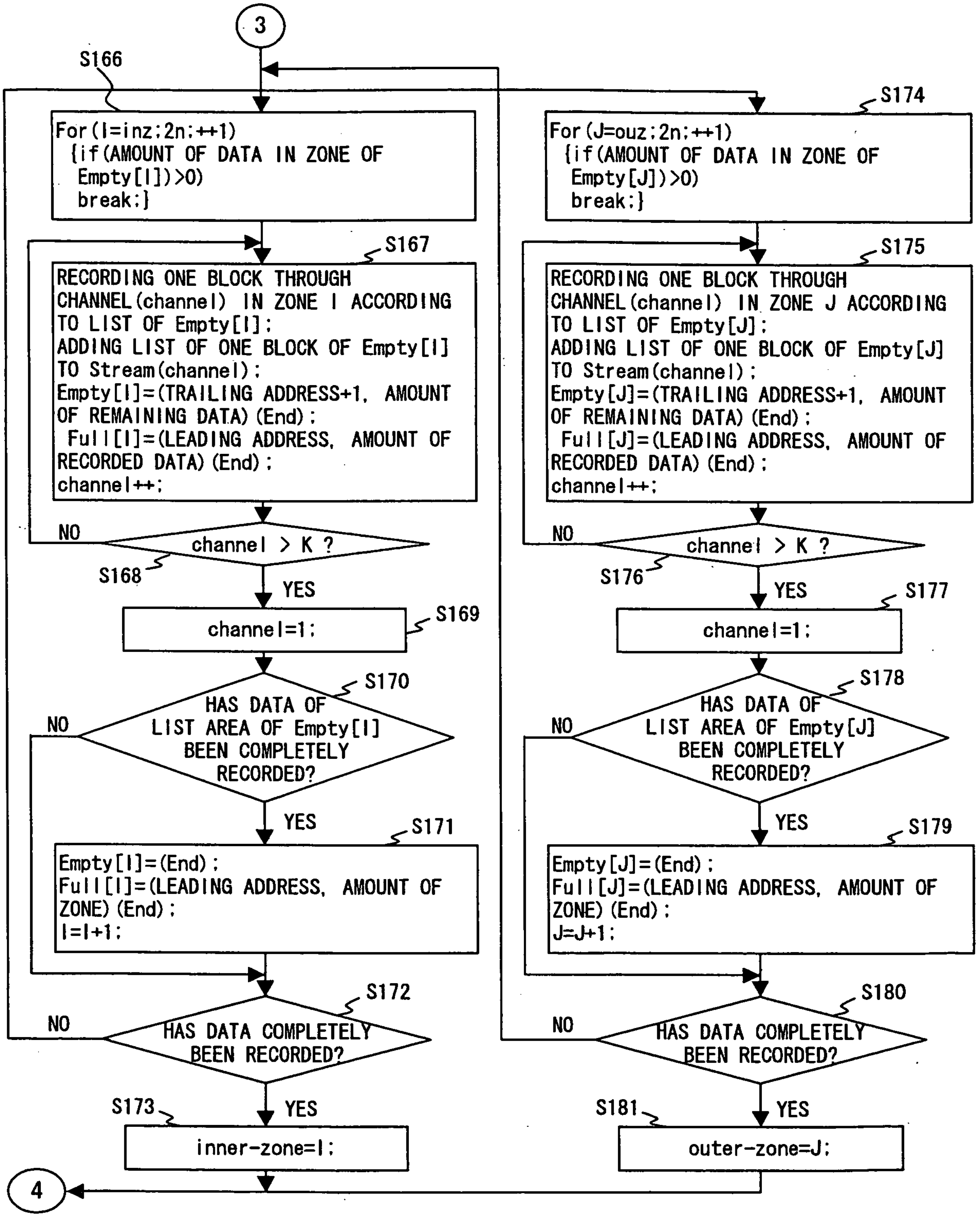

3
S166
For(I=inz;2n;++1)
{if(AMOUNT OF DATA IN ZONE OF
Empty[I])>0)
break;}
S167
RECORDING ONE BLOCK THROUGH
CHANNEL(channel) IN ZONE I ACCORDING
TO LIST OF Empty[I];
ADDING LIST OF ONE BLOCK OF Empty[I]
TO Stream(channel);
Empty[I]=(TRAILING ADDRESS+1, AMOUNT
OF REMAINING DATA)(End);
Full[I]=(LEADING ADDRESS, AMOUNT OF
RECORDED DATA)(End);
channel++;
NO
channel > K ?
S168
YES
channel=1;
S169
S170
NO
HAS DATA OF
LIST AREA OF Empty[I]
BEEN COMPLETELY
RECORDED?
YES
S171
Empty[I]=(End);
Full[I]=(LEADING ADDRESS, AMOUNT OF
ZONE)(End);
I=I+1;
S172
NO
HAS DATA COMPLETELY
BEEN RECORDED?
S173
YES
inner-zone=I;
4
S174
For(J=ouz;2n;++1)
{if(AMOUNT OF DATA IN ZONE OF
Empty[J])>0)
break;}
S175
RECORDING ONE BLOCK THROUGH
CHANNEL(channel) IN ZONE J ACCORDING
TO LIST OF Empty[J];
ADDING LIST OF ONE BLOCK OF Empty[J]
TO Stream(channel);
Empty[J]=(TRAILING ADDRESS+1, AMOUNT
OF REMAINING DATA)(End);
Full[J]=(LEADING ADDRESS, AMOUNT OF
RECORDED DATA)(End);
channel++;
NO
channel > K ?
S176
YES
S177
channel=1;
S178
NO
HAS DATA OF
LIST AREA OF Empty[J]
BEEN COMPLETELY
RECORDED?
YES
S179
Empty[J]=(End);
Full[J]=(LEADING ADDRESS, AMOUNT OF
ZONE)(End);
J=J+1;
S180
NO
HAS DATA COMPLETELY
BEEN RECORDED?
S181
YES
outer-zone=J;

FIG. 57

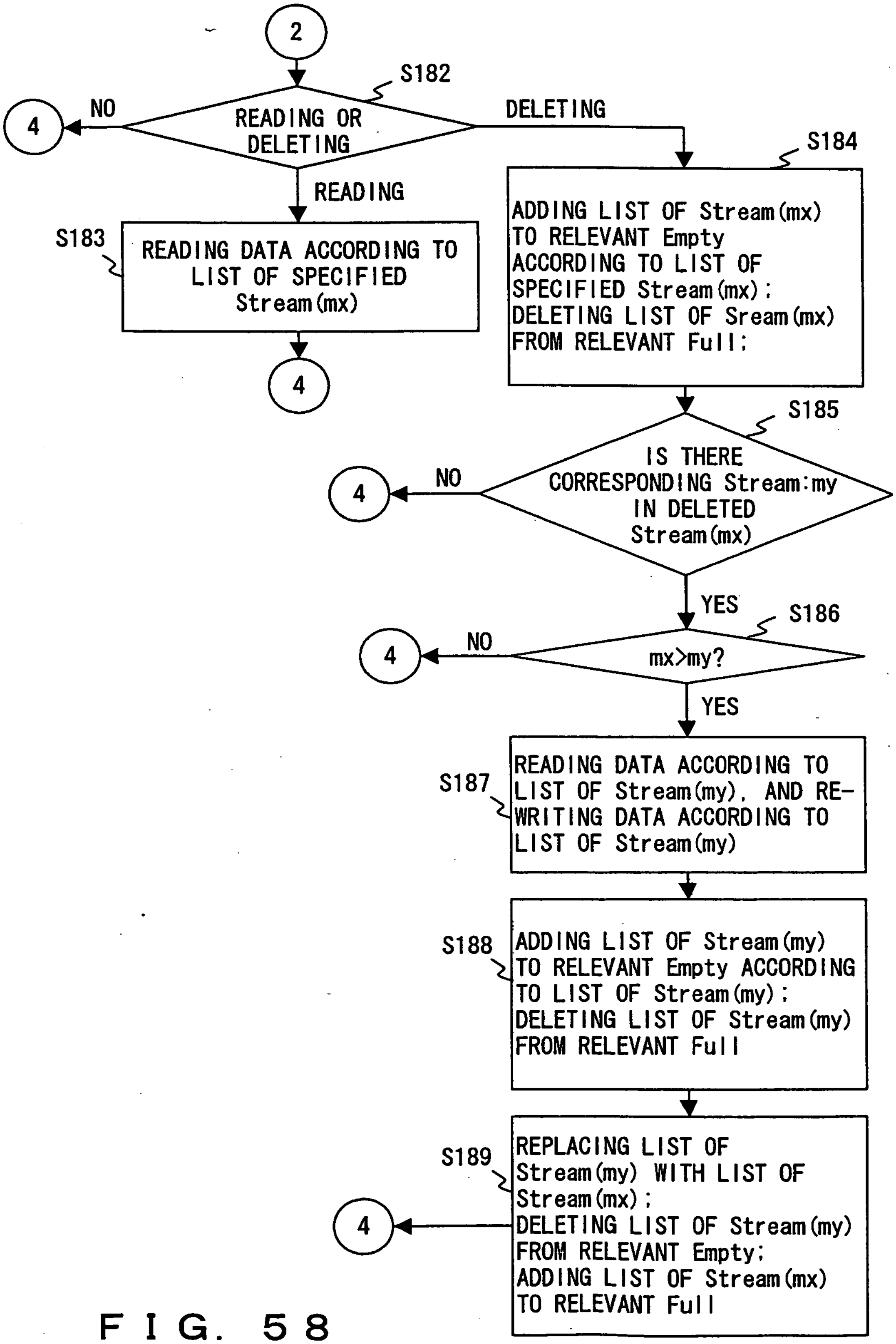

2
S182
READING OR DELETING
NO
4
DELETING
READING
S183
READING DATA ACCORDING TO LIST OF SPECIFIED Stream(mx)
4
S184
ADDING LIST OF Stream(mx) TO RELEVANT Empty ACCORDING TO LIST OF SPECIFIED Stream(mx); DELETING LIST OF Sream(mx) FROM RELEVANT Full;
S185
IS THERE CORRESPONDING Stream:my IN DELETED Stream(mx)
NO
4
YES
S186
mx>my?
NO
4
YES
S187
READING DATA ACCORDING TO LIST OF Stream(my), AND RE-WRITING DATA ACCORDING TO LIST OF Stream(my)
S188
ADDING LIST OF Stream(my) TO RELEVANT Empty ACCORDING TO LIST OF Stream(my); DELETING LIST OF Stream(my) FROM RELEVANT Full
S189
REPLACING LIST OF Stream(my) WITH LIST OF Stream(mx); DELETING LIST OF Stream(my) FROM RELEVANT Empty; ADDING LIST OF Stream(mx) TO RELEVANT Full
4

FIG. 58

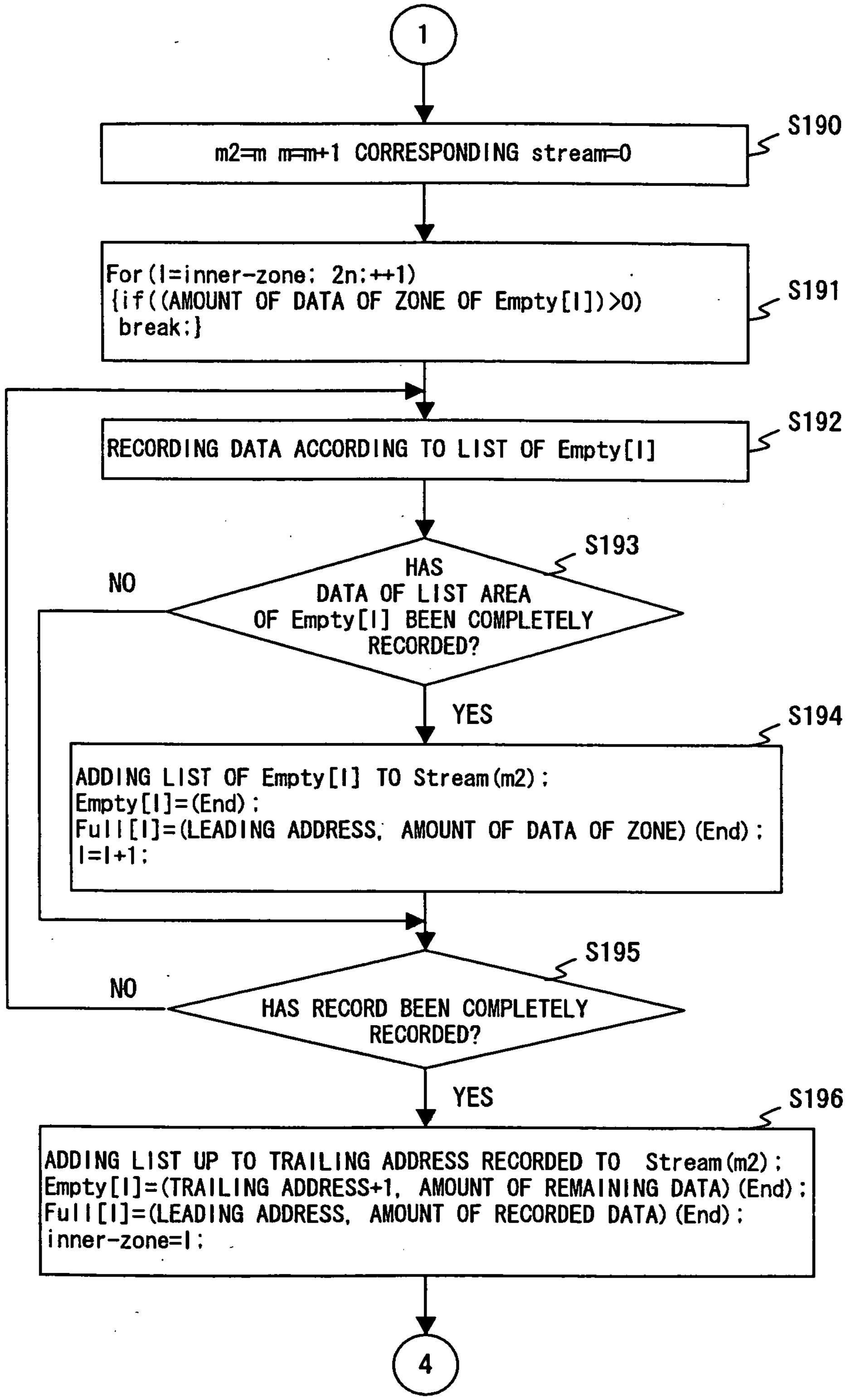

1
m2=m m=m+1 CORRESPONDING stream=0
S190
For(I=inner-zone; 2n;++1)
{if((AMOUNT OF DATA OF ZONE OF Empty[I])>0)
break;}
S191
RECORDING DATA ACCORDING TO LIST OF Empty[I]
S192
HAS DATA OF LIST AREA OF Empty[I] BEEN COMPLETELY RECORDED?
S193
NO
YES
ADDING LIST OF Empty[I] TO Stream(m2);
Empty[I]=(End);
Full[I]=(LEADING ADDRESS, AMOUNT OF DATA OF ZONE)(End);
I=I+1;
S194
HAS RECORD BEEN COMPLETELY RECORDED?
S195
NO
YES
ADDING LIST UP TO TRAILING ADDRESS RECORDED TO Stream(m2);
Empty[I]=(TRAILING ADDRESS+1, AMOUNT OF REMAINING DATA)(End);
Full[I]=(LEADING ADDRESS, AMOUNT OF RECORDED DATA)(End);
inner-zone=I;
S196
4

FIG. 59

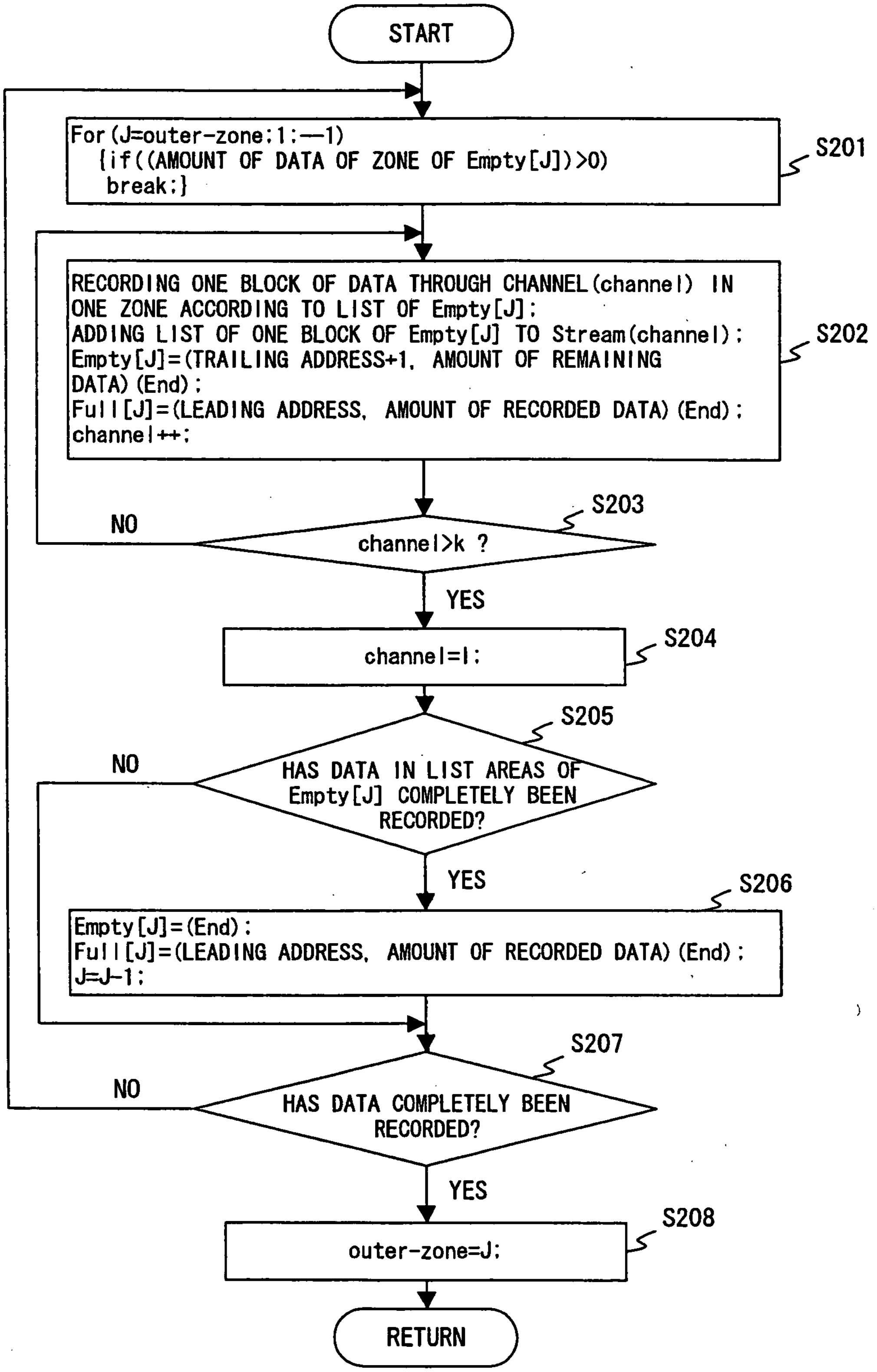

START
For (J=outer-zone; 1; —1)
{if((AMOUNT OF DATA OF ZONE OF Empty[J])>0)
break;}
S201
RECORDING ONE BLOCK OF DATA THROUGH CHANNEL(channel) IN ONE ZONE ACCORDING TO LIST OF Empty[J];
ADDING LIST OF ONE BLOCK OF Empty[J] TO Stream(channel);
Empty[J]=(TRAILING ADDRESS+1, AMOUNT OF REMAINING DATA) (End);
Full[J]=(LEADING ADDRESS, AMOUNT OF RECORDED DATA) (End);
channel++;
S202
NO
channel>k ?
S203
YES
channel=l;
S204
NO
HAS DATA IN LIST AREAS OF Empty[J] COMPLETELY BEEN RECORDED?
S205
YES
Empty[J]=(End);
Full[J]=(LEADING ADDRESS, AMOUNT OF RECORDED DATA) (End);
J=J-1;
S206
NO
HAS DATA COMPLETELY BEEN RECORDED?
S207
YES
outer-zone=J;
S208
RETURN

FIG. 60